SCIENCE ABSTRACTS.

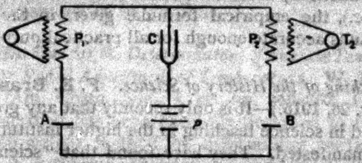
Section A.—PHYSICS.

APRIL 1916.

GENERAL PHYSICS.

412. *Polar Oscillograph and Harmonic Analyser.* (El. World. 67. p. 385, Feb. 5, 1916.)—Gives illustrations, but not detailed descriptions, of (i) a polar oscillograph attachment, which can be used on a standard oscillograph; and (ii) a harmonic analyser designed to give any one harmonic at a time, odd or even, as high as the fiftieth. The polar oscillogram is made on a photographic film about 10 in. in diam., and is then printed on a sensitised piece of Bristol board, from which a templet is cut for use on the analyser. Both instruments are made by the Westinghouse Electric Co. (U.S.A.). A. W.

413. *Precision Method for observing Coincidences of Periodic Phenomena.* **A. Perot.** (Comptes Rendus, 162. pp. 194–195, Jan. 31, 1916.)—Describes a method for determining to an accuracy of about 1/100000 sec. the time of coincidence of two periodic phenomena of such a nature that they can be made to close an electric contact. The apparatus is shown in the Fig. in which A and B are the two contacts; C is a condenser, P_1 and P_2 are the two primaries of the transformers of the two telephones T_1 and T_2. If the contact A is closed before the contact B, the condenser will be charged by the circuit AP_1, and the telephone T_1 will sound; when the contact B is closed there will be no current through the transformer P_2, since the condenser is now charged, and hence the telephone T_2 will not sound. To permit the gradual discharge of the condenser it is shunted with a resistance of some tens of thousands of ohms. Coincidence is observed when the sound in the two telephones is heard simultaneously and of equal intensity. J. W. T. W.



414. *Recording of rapidly varying Phenomena.* **G. Keinath.** (Elekt. Zeits. 36. pp. 633–635, Dec. 2; 651–653, Dec. 9; 662–664, Dec. 16, and pp. 679–682, Dec. 23, 1915. Paper read before the Elektrotechn. Verein, May 18, 1915.)—The author discusses the conditions which must be satisfied for accurate recording in connection with various instruments such as the oscillograph, electro-cardiograph, wattmeter, anemometer, etc. The effects produced by varying the frequency and the damping of the moving parts are very fully dealt with by means of curves. Photographic recording and recording by means of sparks are described in great detail. The paper contains a large amount of information which cannot be usefully abstracted without reference to the numerous curves and diagrams. I. W.

415. *Resistance to Axial Bending and Factor of Safety.* **Gümbel.** (Zeits. Vereines Deutsch. Ing. 59. pp. 1058–1063, Dec. 25, 1915.)—A mathematical analysis of the results of Tetmajer's work shows that the problem of axial bending resolves itself into that of eccentric loading. The equations for the determination of the degree of bending and the stresses produced by a given load are worked out. Attention is called to the importance of the definite workshop control of the true eccentricity of the load applied and of the bending of the bar in the unloaded state. The factors to be introduced in the equations from these causes are worked out. In the definition of the factor of safety of a construction it is shown that not only must the max. stress to which the structure is to be submitted bear a definite relation to the yield stress in tension or compression, but also that the work absorbed must bear the same ratio to the capacity for work up to the yield stress. On this basis the equations for the calculation of the permissible load are worked out and the results exemplified by two numerical examples. F. C. A. H. L.

416. *Bending and Torsion of Beams of Commercial Section.* **E. G. Ritchie.** (Engineering, 101. pp. 49–50, Jan. 21, and pp. 96–97, Feb. 4, 1916.)—The author gives an account of experimental tests, both in bending and torsion, of 21 beam sections, particulars of which are given in a table of dimensions and another large one of results. For these reference must be made to the original. The investigation demonstrates in a striking manner the enormous discrepancies that exist between the actual torsional strength of a beam, and its strength as calculated from the ordinary torsional formula. The experiments on the square and rectangular sections amply confirm St. Venant's mathematical deductions, while for such sections as are used in practice (I, channel, tee, etc.), the empirical formulæ given in the article will, it is claimed, give results accurate enough for all practical purposes. L. H. W.

417. *The Teaching of the History of Science.* **F. E. Brasch.** (Science, 42. pp. 746–760, Nov. 26, 1915.)—It is only recently that any great indication of a change in method in science teaching in the higher institutions of the United States has been manifested. They have found that "science," as a means of education, assumes a broader aspect in courses upon the history of scientific progress.

This paper is divided into two parts, namely: first, the arguments regarding the intrinsic value of the history of science as a study and as a factor in educational efficiency; the second division contains facts, tables, and other material necessary to show the present condition and trend of the subject.

It is concluded that the general course, as opposed to specific courses, is coming to be the accepted standard for history in science. L. H. W.

418. *Theory of Water-hammer.* **C. Fossa-Mancini.** (N. Cimento, 10. pp. 329–426, Nov.–Dec., 1915.)—This lengthy monograph is entirely of a mathematical character, the subject being dealt with under the following heads: Instantaneous closing in an elastic-walled pipe with a compressible fluid; Slow closing in a rigid pipe with incompressible liquid; Slow closing in an elastic-walled pipe with compressible liquid; Effect on the water-hammer of an air chamber or a stand-pipe. It is concluded that the utility of an air chamber is the greater the more rapid the closing and always becomes less as the rapidity of closing diminishes. For the stand-pipe, on the other hand, the value of this is greater, the longer the duration of the closing process. For extremely rapid closing the stand-pipe has no appreciable effect. L. H. W.

419. *Capillarity (Soap Films).* **J. Dewar.** (Engineering, 101. pp. 87–88, Jan. 28, 1916. Discourse delivered before the Roy. Inst.)—The rate of diffusion of various gases through very thin membranes of rubber, studied between —40° and + 40° C. and at pressures up to 20 atmos., increases in the order: carbon monoxide, air, helium, oxygen, hydrogen, carbon dioxide; in all cases the diffusion is much more rapid as the temperature rises, especially for H and CO_2, and the logarithmic curves all show breaks at about 0° C. Experimenting with thinner films, it was found that the thinnest black soap-films are not unstable if made in pure air or, better still, in a vacuum. The minimum thickness of films has been estimated at 120×10^{-6} mm. by Plateau, at 40 down to 12 by Reinold and Rücker, at 5 by Johonnot, at 1·13 by Rayleigh, and at 2 or 3 by Devaux (the last two did not use soap-films); Dewar estimates his soap-films at 1×10^{-6} mm. Black films will keep for months and may be rocked to and fro. They are easily produced by shaking the oleate solution contained in an evacuated bulb and allowing the froth to settle, when more than a dozen horizontal films may appear in a bulb resembling a wide thermometer tube. Circular or rectangular loops of Pt-wire may be fixed in these bulbs to steady the advance of the black film portion which spreads downward within a few minutes or hours. This rate of fall of the black line ranged, with horizontal and vertical films, in air or vacuum, from 4 mm. per min. down to 0·016 mm. Another form of apparatus is obtained by blowing the two upper bent limbs of a kind of Y-tube into spherical cups until the rims of the cups touch; the soap solution is contained in the lower limb, and films form especially in the plane where the two cups unite. This apparatus is placed in a black box suitable for optical examination of the films. H. B.

420. *Simple Apparatus for the Determination of Surface Tension, with a Metal Thermo-regulator for Rapid Adjustment of Temperature.* **W. D. Harkins** and **F. E. Brown.** (Am. Chem. Soc., J. 38. pp. 246–252, Feb., 1916.)—The apparatus here described has been carefully designed to fulfil the requirements of the drop-weight method of determining surface tension. In conjunction with it, a thermo-regulator is used which is constructed of nickel-plated steel and filled with mercury; by means of a regulating screw the regulator may be set very quickly at any temperature between 1° and 97°. T. H. P.

421. *Surface Tension.* I., II., III. **W. D. Harkins** and **E. C. Humphery.** (Am. Chem. Soc., J. 38. pp. 228–236, 236–241, and pp. 242–246, Feb., 1916. Paper read before the Nat. Acad. Sci., Dec., 1914.)—The

capillary tube method of determining surface tension is found to be inaccurate whenever aqueous solutions of bases are used, but the drop-weight method gives accurate results. This difference is due to the fact that, in the capillary tube method, the surface of the liquid is very small and thus highly sensitive to the influence of impurities; further, there is in this method always the doubt as to the magnitude of the contact angle. The surface of a drop such as is used in drop-weight determinations is, on the other hand, relatively large and may also be formed very quickly and thus give a fresh surface, and the theory of the form of the drop gives no indication that the angle of contact is dependent on the material of the tip if the latter has the proper form. Lohnstein's theory of the form of the function which must be inserted in the equation giving the surface tension α in terms of the weight of the falling drop, W [see Abs. 1667 (1906), 610 (1907), 747 (1908)] has been tested experimentally at the interface between two liquids. From the standpoint of the theory of drop-formation this is an ideal method, since in a liquid the drop falls much more slowly than in a gas. Lohnstein calculated the values of the function of r/a in the equation, $\alpha = W[2\pi r f(r/a)]$. Lohnstein's values of this function, and the experimental values give curves of exactly the same form, especially in the initial stages where $f(r/a) = 1$ and $r/a = 0$. For higher values of r/a Lohnstein's curve is not smooth, but sinuous, probably owing to neglect to carry the integrations sufficiently far; these values are not accurate to less than 4 %, but are of importance since they prove that such laws as that of Tate are only approximations.

The surface-tension curve is somewhat flat at the bottom, and Tate's law assumes that the horizontal tangent is the same as the curve. Other tangents can, however, be drawn which approximate as closely to the curve as does the horizontal one, so that other laws, as good but not as simple as that of Tate, can be formulated. The correction curve found experimentally is lower than corresponds with Morgan's values [Abs. 1378 (1915)], owing to the fact that the latter are based on the low values of the surface tension found by Ramsay and Shields and others by the capillary tube method.

An apparatus, simple to set up and use, has been devised for the accurate determination of surface tension at a liquid-liquid interface. This may be used for the determination of the surface tension of a single liquid, but that described by Harkins and Brown [preceding Abs.] is more suitable for this purpose. Another apparatus, for measurements by the capillary tube method, is also described, the tube containing the large meniscus being 10 cm. in diam.; the results obtained were checked by making the large meniscus about 15 cm. By the use of such large tubes the commonest error in capillary height measurements is avoided [compare Richards and Coombs, Abs. 1372 (1915)].

The surface tension has been determined at the interfaces between water and the following liquids: benzene, ethyl carbonate, dimethylaniline, xylene, toluene, and hexane. The results for water-benzene are about 6 % higher than those of v. Lerch [Abs. 533 (1903)] and Antonow; this change is in the same direction as that found by Richards and Coombs for the surface tension of single liquids. The effects of acids, bases and salts on the surface tension at the water-benzene interface have been studied. The effect of bases is much smaller than was found by v. Lerch, the new results being in some cases as much as 85 % higher than the older ones; this difference is due to a change from the capillary tube to the drop-weight method. T. H. P.

LIGHT.

422. *Infra-red Filtering Screen from* 8000 *Å.U.* **G. Michaud** and **J. F. Tristan.** (Archives des Sciences, 41. pp. 53–58, Jan. 15, 1916.)—A substance is sought that is opaque to waves of shorter length than 7950 Å. but transparent for the whole or greater part of the region between 7950 and 10,500 Å.U. A combination of three colours, chrysoidine (chlorhydrate of diamidoazobenzene), methyl green and naphthol green, is found satisfactory. Chrysoidine is a brown powder, the solution of which varies from yellow to orange-red with the concentration. It absorbs the violet, blue, and green from 3700 to 5800 Å. It allows the ultra-violet of sunlight to pass. This is absorbed by the methyl green, which also absorbs the yellow, orange, and red beyond 5800 Å. The opacity of the methyl green ceases towards 7200 Å.; the transparence of the solution for the extreme red and infra-red then becomes extraordinary. The naphthol green finally completes the opacity of the screen for the region between 8500 and 8900 Å. The following solutions contained in cells 3 mm. diam. each, and superposed, give the best results: Chrysoidine, 1 % aqueous solution; methyl green, 2 % aqueous solution; naphthol green, an aqueous solution varying in concentration from 1 % to 2 % according as it is desired to extinguish, beyond the extreme red, a length more or less considerable in the infra-red. These three coloured solutions cannot be used as a mixture in the same cell since the naphthol green forms a precipitate with the other solutions. The length of exposure must be multiplied by a coefficient which varies between 600 and 10,000 according to the concentration of the naphthol-green solution. A. E. G.

423. *Quantitative Light-filter for the Ultra-violet.* **N. P. Peskov.** (Russ. Phys. Chem. Soc. J. 47. pp. 918–942, 1915.)—By the qualitative investigation of spectrograms, the author has devised a light-filter, in which gaseous bromine and chlorine are used in conjunction, which absorbs the spectral region 500–300 $\mu\mu$. By means of an improved modification of Henri's photographic method [Abs. 1558, 1559 (1911); 1679 (1912); 1818, 1819 (1913)] for determining coefficients of absorption in the invisible part of the spectrum, these coefficients have been measured for gaseous Cl and Br for 48 lines of the spectrum of the quartz lamp. The process of absorption of light in mixtures of several absorbing components is formulated mathematically, and by means of the formulæ deduced it is shown experimentally that, when dry Cl and Br are mixed, the characters of their absorption remains unchanged, Beer's law being consequently obeyed. The light-filter has been subjected to detailed quantitative investigation, concentrations of Br and Cl being found which permit of the filtering of any part of the spectrum chosen beforehand; this filtration may be restricted within such narrow limits as 250 and 240 $\mu\mu$. T. H. P.

424. *Photography of Zodiacal Light and Counterglow.* **A. E. Douglass.** (Phot. J. 56. pp. 44–47; Disc., 47–48, Feb., 1916.)—Successful photographs of these phenomena of very slight contrast were obtained by careful consideration of the conditions to give even illumination and intensification of photographic contrast. A camera lens of very large relative aperture was used (diam. 1 in., focal length 2 in.), with exposures varying from 3 to 20 mins.

Equally good results were obtained with orthochromatic and ordinary plates, and it was found best to develop with hydroquinone and bromide, kept cool, arranged for prolonged development. Evenness of illumination was got by using a special form of panoramic camera, with a focal diaphragm 17 mm. wide, the lens rotating at the rate of 2° per min. The instrument was provided with 3 exactly similar lenses rotated by the same clock, so that three negatives were produced for each exposure. For producing positives these negatives were put together and the copy taken through the combined pictures, thus increasing the contrast values given by a single film.

In the discussion of the paper the question was raised whether it might not be better to make a series of positives from each negative, and superpose these for the increase of contrast instead of the negatives. Also the importance in such work of attending to the perfect cleanliness of the lens surfaces, elimination of lens or camera glare, danger of diffraction with small apertures, etc. C. P. B.

425. *Michelson Interferometer.* **G. Krause.** (Ann. d. Physik, 48. 8. pp. 1037–1060, Feb. 1, 1916. Abstract of Dissertation, Breslau.)—Gives mathematical theory, with experimental verification, of the interference phenomena obtained when the compensating plate in a Michelson interferometer is inclined to the reflection plate. [See also Abs. 1690 (1911).] A. W.

426. *Illumination of Field of Photographic Objective.* **H. C. Lord.** (Roy. Astron. Soc., M.N. 76. pp. 197–204, Jan., 1916.)—Omitting any allowance for losses by reflection or absorption, a geometrical method is developed for computing the intensity of the illumination at any point of the field of a photographic objective. C. P. B.

427. *Tyndall Effect and Size of Colloidal Particles.* **W. Mecklenburg.** (Kolloid Zeits. 16. pp. 97–108, April, 1915.)—The Tyndall meter of the author (Ibid. 14. pp. 172–181, 1914) is a photometer which compares the intensity of the Tyndall beam in a direction normal to the beam, with the intensity of the incident light by reflecting a portion of the latter and weakening it with the aid of Nicol prisms. The intensity J of the Tyndall beam decreases, of course, with the length of path through the colloidal medium. The new experiments concern colloidal sulphur prepared after S. Odén, who himself measured the size of the particles, from 5 up to 840 $\mu\mu$. The first four groups (diameters 5, 10, 20, 80 $\mu\mu$) could not be measured with the ultra microscope, and were estimated by the author from their diffusion and osmotic pressure phenomena. All the solutions were fairly homogeneous as to size of particles. If n be the number of particles per unit volume, v the volume of a particle, s the density, $c = nvs$, and J the intensity, then $kcv/s^2 = J\lambda^4$ according to Rayleigh, or $= J\lambda^2$ according to Clausius. The Tyndall effect is found to be proportional to the concentration of the solution (if homogeneous as to size of particles). When the diam. of the particles is less than 100 $\mu\mu$ (measurements of 42 $\mu\mu$ and 98 $\mu\mu$), the λ^4 law holds; for particles from 250 to 840 $\mu\mu$ (measurements at 246 and 842), the λ^2 law holds; for the 185-$\mu\mu$ particles neither law applies, and the author suggests a gradual transition from the one type to the other with increasing size of particles. H. B.

428. *Opacity of Diffusing Media.* **O. Bloch and F. F. Renwick.** (Phot. J. 56. pp. 49–66, Feb., 1916.)—The object of the investigation is to determine whether, as Hurter and Driffield had suggested, there is any direct

connection between the optical opacity of a dry plate and its properties as a light-recording medium. The previous work on the subject is briefly considered. Any satisfactory method of measurement must be one which would either separately measure, or eliminate altogether, both "surface reflection" and "scatter" losses, and accordingly in the first instance the method used by Callier, and by most other workers since, of placing the film of the dry plate in contact with opal glass during measurement is adopted. A simple form of bench photometer is evolved from Ferguson's bench photometer, but having the great advantage of using only one source of light, which is kept stationary all the time, matching being effected by using a pair of mirrors, set at 90°, along the photometer bar. At first sight no simple relationship appears to exist between the density and the weight of material per unit area, but on plotting the logarithms of these quantities against one another, it is found that the relationship is expressed by a simple straight line. Abney's suggestion that the effect is due to selective light absorption by the emulsion did not seem tenable when viewed in the light of results with white emulsions of bismuth oxychloride and silver chloride, and there appear to be only two alternative explanations: either the departure from the simple law of proportionality is due to the method of measurement being wrong, or the density is indeed not proportional to the quantity of material present per unit area. Passages which bear more particularly on the special problem of opacity or density measurement are quoted from a series of "Reports on Diffusing Media" [Abs. 1401 (1915)]. The present experiments show that whenever piles of solid opal glasses of similar size, form, and quality are measured with the utmost care under the most varied conditions which seem at all permissible, results agreeing very accurately indeed with the general expression $\log D = a \log T + b$ are invariably obtained, but that the factor "a" varies widely with the conditions of measurement and also with the quality of the sheet they were cut from, the values ranging from as low as 0·6 to a trifle over 1. An examination of the results in relation to the conditions leads to the conclusion that the specific density of solid opal glass is independent of thickness. The results obtained with emulsions on glass all go to show that, when measured visually by minus-red light, the apparent density of a silver bromide emulsion ranges from 0·22 to 0·28 per mgm. of AgBr per cm.^{2}, and increases by from 50 to 60 % each time the thickness of coating is doubled. The results obtained by the exposure of a rapid-plate emulsion behind a wedge of the same emulsion for 75 secs. at 250 cm. to a 16-c.p. metal filament lamp whose light was filtered through a 12½-mm. layer of ammoniacal copper sulphate transmitting λ8800–4600 support the view that the value of the power depends both on the reflection coefficient of the medium and the conditions of measurement, and not upon selective absorption as Abney supposed.

The relation between readings of different kinds of photometers is discussed. The problem how to measure the true density of an emulsion remains only half solved; the results obtained not only draw attention to the experimental difficulties, but indicate that the conditions under which such measurements should be made are not yet fully understood. The rule, which has been found to hold good under all sorts of circumstances, serves as a useful criterion of the suitability of any conditions employed. A. E. G.

429. *Stereoscopic Apparatus for examining Radiographs so as to obtain either Normal or Pseudoscopic Relief.* **E. Colardeau** and **J. Richard.** (Comptes Rendus, 162. pp. 265–268, Feb. 14, 1916.)—When a stereoscopic view intended for examination with the right eye is looked at with the left, and that for the left with the right, an inverse relief effect is obtained which is known as pseudoscopic. The front plane appears as if behind, and *vice versa*. Stereoscopic radiographs made by the usual method of displacement of the bulb produce this pseudoscopic relief very clearly. A case in which a piece of shell is embedded between the skin of the back and the vertebral column is cited as an example where this may be useful. A stereoscope with double eyepieces is devised, the eyepieces being instantly interchangeable, so that the observer can pass at once from the normal to the pseudoscopic relief. The eyepieces used for obtaining the normal relief are of the ordinary type, consisting of two converging lenses. For the production of the pseudoscopic view an optical system composed of two special prisms, which are described, is placed in front of each eyepiece. A. E. G.

430. *Absolute Electro-optic Retardation and Acceleration in Electric Double Refraction.* **F. Himstedt.** (Heidelberg Akad. d. Wiss., Sitzungsber. 8, 1915. Ann. d. Physik, 48. 8. pp. 1061–1088, Feb. 1, 1916.)—Light from a 30 to 40-amp. arc lamp with horizontal positive carbon is polarised and then gives a spectrum from which a particular wave-length is taken and divided into two parallel beams. These pass through a Kerr cell, one between the charged electric plates and one outside. They then give interference bands in the upper and lower parts of the same field of view. As the plates are charged one set of bands moves with respect to the other, and the acceleration or retardation is found accordingly.

With CS_2 it was found that the light polarised at right angles to the electric field experiences a retardation, the light polarised parallel to the field an acceleration. The ratio of the two effects is 4 : 1. Chlorbenzol gives the same results.

An oil (castor oil) with a negative Kerr coefficient was then tried. It gave results like CS_2 but interchanged with the contrary sign, the ratio being —1/4. E. H. B.

431. *Anomalous Dispersion of Rotatory Power and Circular Dichroism.* **G. Bruhat.** (Ann. de Physique, 3. pp. 252–282, March–April, and pp. 417–489, May–June, 1915.)—The paper is divided into three parts. Having reviewed the history of anomalous rotatory power (Biot) and of circular dichroism accompanying selective absorption (Cotton, 1896), the author describes experiments of his own made with a spectropolarimeter comprising a Glazebrook polariser and an Ahrens-Lippich analyser, on hydrogen and potassium nickel tartrates, uranyl tartrate, some organic copper and calcium salts, and diphenylbornylimidoxanthide, either dissolved in toluene or superfused. Some of these substances are well defined chemically and well crystallised, whilst the effects had formerly been observed under less favourable conditions. It would appear that circular dichroism and anomalous dispersion are general properties of active isotropic media possessing selective absorption in the visible spectrum.

In the second part the author shows that the electromagnetic theory of Drude of the propagation of light in active absorbent media covers these anomalies (which was denied by Ritz) and also the relation of Natanson that on the red side of an absorption band the less-absorbed light is propagated at a quicker rate and the anomaly of the refractive dispersion is positive, the opposite holding for the violet side. The author confirms this rule and deduces further quantitative relations from an examination of the observations by himself and others. He extends the consideration to cases in which there is more than one class of electrons which would give rise to one absorption band only. The relations hold for simple and complex salt solutions, for organic compounds not containing metals, and for the diphenyl compound mentioned, dissolved or superfused, and some of its derivatives. In the case of tartaric acid itself, however, the anomalous dispersion is not accompanied by dichroism, and must hence be explained on chemical grounds by the assumption that the solution contains two active compounds in equilibrium in proportions which vary with the solvent, temperature, and concentration. But since the phenomena are the same for solutions and for the pure superfused acid, and since a rise of temperature has the same influence as dilution, the author concludes that the two substances are tartaric acid and a polymer, the latter being present in small proportion but possessing high rotatory power. H. B.

432. *Magnetic Rotation of the Plane of Polarisation in Titanium Tetrachloride.* II. **L. H. Siertsema.** (K. Akad. Amsterdam, Proc. 18. 6. pp. 925–932, 1916.)—In continuation of the work previously published [Abs. 1252 (1915)], it is now shown mathematically that the dispersion of the magnetic rotation of titanium tetrachloride is explainable by the theory of Lorentz ("Theorie der magneto-optische Phänomene," Encykl. der math. Wiss., vol. 3, p. 199). T. H. P.

433. *Arc Spectra of the Platinum Metals in the Extreme Ultra-violet.* **G. Kail.** (Akad. Wiss. Wien, Ber. 123. June, 1914. Chem. Zentralblatt, I. pp. 802–808, 1915.)—The total number of lines measured is 1071, and 690 of these were new. With the aid of known lines a dispersion curve was plotted for the quartz spectrograph employed. The shortest wavelengths determined for the respective metals are: Rh, 1880·00 Å.; Ru, 1874·94; Pt, 1866·46; Pd, 1858·51; Ir, 1852·21. H. B.

434. *Arc Spectra in the Red and Infra-red in International Standards.* **J. M. Eder.** (Akad. Wiss. Wien, Ber. 123. Dec., 1914. Chem. Zentralblatt, I. p. 1046, 1915.)—The investigation concerns the elements Li, Na, K, Cs, Rb, Ca, Sc, Ba, Zr, La, Ce, and the range λ6400 to 8500 Å. Many so far unknown lines and satellites are measured in the visible red, and the infrared is joined without gap. Photographs were taken with Schleussner plates sensitised with dicyanin, the light being concentrated into a band on the slit by means of two crossed cylindrical lenses (rock crystal); the exposures could then be reduced to from 3 to 20 minutes. H. B.

435. *Arc Spectrum of Gold in International Standards.* **M[arie] Quincke.** (Zeits. wiss. Phot. 14. pp. 249–261, March, 1915.)—The work was done under Kayser with a Rowland grating, but the apparatus were mounted after Abney. The tables give the author's determinations together with those of Kayser and Runge, Exner and Haschek, and Duffield. The agreement is not always perfect; some lines are new, some probably due to impurities, as to which reference is made to Holtz, Hasbach and Buchholz. The range is 6698 to 2352 Å., measurements being made to 0·001 Å., and the intensities estimated after Kayser and Runge. There are not any distinct series. H. B.

436. *Arc Spectrum of Manganese in International Standards.* **H. Fuchs.** Zeits. wiss. Phot. 14. pp. 239–248, Feb., and pp. 263–280, March, 1915.)—The

International Congress for Solar Research in 1910 resolved to base international line standards on the red line of Cd, and the determinations were made by Fabry and Buisson, Eversheim, and Pfund. The author experimented under Kayser with grains of manganese (from Merck), fused in the hollow positive carbon electrode of a 200-volt arc at 6 to 8 amps. with horizontal or vertical electrodes, taking the spectrum with a concave Rowland grating (6·34 m. radius, 20,000 lines to the inch) and photographing with Schleussner and orthochromatic plates; the general arrangements and measurements after Kayser. The paper is mainly tabular, and the many pages of tables concern the range 7069·855 to 2289·98 Å.; the long waves required exposures of 1½ hours. The tables also give the values of Exner and Haschek, Kilby (from whom the author frequently differs), Burns, and Hamm. H. B.

437. *Influence of Electric Field on Hydrogen Lines.* **J. Stark.** (Gesell. Wiss., Göttingen, Nachr. pp. 427–444, 1914. Chem. Zentralblatt, I. p. 592, 1915.)—In conjunction with Wendt and Kirschbaum [Abs. 75 (1914)] the author had formerly made use of fields of 80,000 volts/cm. In order to ensure greater sharpness of the lines, he has raised his field intensity to 104,000 volts/cm., and has thereby obtained both further separation and increased intensity of the hydrogen lines. The inhomogeneity of the field in the canal-ray tube, moreover, makes the lines curved and admits of distinguishing the components from foreign lines. As the intensity range of the lines is much greater than in the Zeeman-effect, the strongest and weakest lines were not photographed on the same plate, but on separate plates. The distances between the lines H_α, H_β, H_γ, H_δ are in each case proportional to the strength of the field, and several electrons are always concerned in the emission of a series line. H. B.

438. *Fluorescence of Sulphur, Selenium and Tellurium Vapours.* **D. Diestelmeier.** (Zeits. wiss. Phot. 15. 1 and 2, pp. 18–55, June and July, 1915.)—Since all fluorescent substances show selective absorption, either in the series lines or in the absorption bands (for which reasons two classes may be distinguished), the author tried to prove that S, Se, Te, displaying selective absorption, should be fluorescent. The experiments were made in glass or quartz vessels, heated (up to 750°) by burner or in an electric furnace, and joined to a pump. The exciting illumination was by means of sunlight, carbon arc lamps, salt vapours (salts in hollow carbon electrodes), and arcs of the metals U, V, Ti, Mo, etc. The substances were commercially pure. The sulphur at first did not show a trace of fluorescence; it was purified by being submitted to repeated sublimations in a glass tube provided with many strictures and by other means; the vapour then fluoresced in quartz vessels when the pressure was sufficiently reduced. Selenium and tellurium fluoresce more readily. The conclusion is that vapours of S, Se, and Te only fluoresced in the superheated condition at low density; the carriers of the fluorescence are the diatomic molecules which are very sensitive to impurities; excitation by sparks was successful only in the case of sulphur. As the atomic weight of the substance increases, the activity of the exciting illumination shifts from the ultra-violet over the red end, and the fluorescence changes in appearance with the nature of the excitation. The fluorescence is bluish, shading into white or violet; tellurium vapour turns, from faint blue, more greenish blue and lighter at higher temperatures. Density, temperature, and pressure affect the spectra. The fluorescence (emission) spectrum of sulphur joins its absorption spectrum; in the two other cases the two spectra of the same element overlap, and certain bands are common to them; but the apparatus was not sufficiently delicate for exact measurements of the complex spectra. A shading of the lines or bands towards the red was mostly noticed. The similar experiments of Steubing date from the same year (1913). H. B.

439. *Relations between the K and L Series of High-frequency Spectra.* **M. Siegbahn.** (Nature, 96. p. 676, Feb. 17, 1916.)—The results are given of an investigation, by E. Friman and the author, on the spectra of the L series. It is shown that there is in reality an additional line near L_a, with a slightly greater wave-length. The tabulated observations of wave-lengths are in good agreement with those of Moseley, and with the values calculated from Malmer's modification of Kossel's relation. According to Malmer the K series consists of four lines [see Abs. 1535 (1915)], called a_1, a_2, β_1, and β_2, and that Kossel's relation must take the form $\nu_{L_a} = \nu_{K\beta_1} - \nu K_{a_2}$. This relation is verified experimentally. A. B. W.

440. *High-frequency Spectra of the Elements Gold-Uranium.* **M. Siegbahn** and **E. Friman.** (Phys. Zeits. 17. pp. 17–18, Jan. 15, 1916. Phil. Mag. 31. pp. 403–406, April, 1916.)—Moseley has shown [see Abs. 1249 (1914)] by the X-ray method of determination of the atomic numbers of the elements, that between Al and Au there are only three elements as yet unknown. In the present investigation the range of elements from gold to uranium has been examined. The main results are included in the following table :—

Element.	Atomic Number. N.	Wave-length. $\lambda_a \times 10^8$ cm.	$\sqrt{1/\lambda} \times 10^{-4} = \sqrt{\nu} \times 10^{-4}$.	$Q_L = \sqrt{\frac{\nu}{5\nu_0/36}}$.	$N - Q_L = b$.
Au	79	1·280	0·884	71·6	7·4
Hg	80	1·243	0·897	72·7	7·3
Tl	81	1·209	0·909	73·7	7·3
Pb	82	1·179	0·921	74·6	7·4
Bi	83	1·157	0·930	75·3	7·7
—	—	—	—	—	—
Th	90	0·971	1·015	82·2	7·8
—	—	—	—	—	—
Ur	92	0·919	1·043	84·5	7·5

The mean value of b (where $b = N - [\nu/(5\nu_0/36)]^{1/2}$; *i.e.* Moseley's relation) from these observations is 74. Between Bi and Th there exist 6 unknown elements, and between Th and Ur one element. A. B. W.

441. *Energy Measurement of Ionising Radiation—in particular X-radiation.* **T. Christen.** (Phys. Zeits. 17. pp. 23–25, Jan. 15, 1916.)—The importance is demonstrated of not overlooking the effect of the absorption coefficient of air in measurements of this character. In making measurements on the production and intensity of X-rays of varying grades of hardness, experimenters are rather apt to overlook certain principles, and as a consequence are led to wrong conclusions. The cases of X-radiation absorbed in air and in water are discussed. There seems to be some doubt as to whether or not the ratio between the radiant energy absorbed by the air and the ionisation, is constant, *i.e.* is independent of the hardness of the radiation. A. B. W.

442. *Effect of Magnetisation on Opacity of Iron to Röntgen Rays.* **A. H. Forman.** (Phys. Rev. 7. pp. 119–124, Jan., 1916.)—Negative results were obtained from an investigation of the effect of magnetising the iron in a plane perpendicular to the path of the Röntgen rays. A change of one part in 10,000 could be detected [see Abs. 1587 (1914)]. The present paper describes work with the iron magnetised in a direction paralled to the path of the Röntgen rays. The apparatus was similar to that used in the earlier experiments, and with the same piece of iron an increase of opacity was found when it was magnetised parallel to the Röntgen rays (perpendicular to the kathode stream of the X-ray tube). The effect seems to be about 5 parts in 8000 for a field of 8500 gauss. Since soft iron is saturated at an induction of about 15,000 the iron molecules are only slightly oriented in a field of 8500 gauss, and a greater effect may be expected with a field of 15,000 gauss or over. The experiments indicate that the iron is less transparent to the more penetrating Röntgen rays when it is magnetised in a direction parallel to the path of the Röntgen rays. Assuming that the Röntgen ray is due to a disturbance created by an electron whose motion is in the direction of the kathode stream of the X-ray tube, it is to be expected that the absorption of energy from the Röntgen rays will be by those parts of the molecule free to vibrate in the same plane; and unless the molecule is symmetrical about all its axes there is a plane through it where the absorption is a maximum. Magnetising the iron will tend to align the molecules so that they will have their planes of max. absorption parallel to one another. If the planes of max. absorption are parallel to the kathode stream of the X-ray tube then the iron will seem more opaque. The results obtained indicate that the plane of max. absorption of the iron molecule is parallel to that of the electronic orbits which make up the elementary magnet. The author considers that the failure of the Röntgen ray to ionise all the molecules of a gas through which it passes may be explained as due to the molecule having only one plane in which it can absorb sufficient energy from the Röntgen ray for ionisation.

J. J. S.

443. *X-ray Photographs showing "Depth."* **B. Alexander.** (Phys. Zeits. 17. pp. 15–16, Jan. 1, 1916.)—In a previous paper [Abs. 1270 (1915)] the author described in detail the method of procedure for obtaining X-ray photographs of this character. To illustrate the principal points to be observed a series of photographs were shown of a fine metal gauze photographed under different conditions. The present paper describes further experiments on the same lines, an excellent "perspective" photograph of a folded wire gauze being reproduced in illustration. A. B. W.

444. *Physical Measurement of X-rays.* **H. L. Bronson.** (Nova Scotian Inst. of Sci., Proc. and Trans. 14. pp. 17–29, Oct. 14, 1915.)—It has been shown that the action of Röntgen rays on a photographic plate and on a Sabouraud pastille is proportional to the ionisation produced in the air immediately surrounding them. Making use of this principle, a simple apparatus has been devised for measuring the intensity and hardness of the rays. The same apparatus can readily be used to determine the length of time of exposure needed to produce radiographs of suitable density.

A. B. W.

RADIO-ACTIVITY.

445. *Chemical Identity of Radium-D and Lead.* **G. v. Hevesy** and **F. Paneth.** (Deutsch. Chem. Gesell., Ber. 47. pp. 2784–2786, Oct. 24, 1914.)—Having an unusually large quantity of emanation (1 Curie from 1 gm. of Ra) at their disposal, the authors succeeded in obtaining visible deposits of RaD and of its peroxide, and in submitting these to potential tests. The emanation was allowed to decay for several weeks in a quartz bulb, which was then washed with nitric acid, and the solution electrolysed; under different conditions about 0·005 mgm. of RaD or of $RaDO_2$ were obtained, and found pure by radio-activity tests. The nitrate solution $RaD(NO_3)_2$ was then coupled in cells with $RaD(O_2)$ or with PbO_2; the e.m.f.'s observed were identical, also after adding lead ions to the solutions. The authors hence assume that the—so far inseparable—isotopes RaD and Pb are not only similar but chemically identical, and that, in accordance with Rutherford and others, equality of the number of nucleus charges only—not of all the properties depending upon the surrounding rings of electrons—is required to make two chemical atoms appear as identically one and the same element. [See also Abs. 578 (1914).] H. B.

446. *Atomic Weight of "Uranium-Lead."* **O. Hönigschmid** and **S. Horovitz.** (Monatsh. d. Chemie, 36. pp. 355–380, May, 1915.)—Lead ores may be supposed to contain Pb, AcE (generally accompanying U, from UY, atomic weight probably 210), and RaG or uranium lead (from RaF or polonium by loss of one α-ray). The minerals examined are: (1) purest pitchblende from Joachimsthal; 20 kg. of this yielded a lead apparently of atomic weight 206·405, probably a mixture of RaG, AcE, and ordinary lead; (2) a crystallised uranium ore from Morogoro (German East Africa, primary geological formation), studied by Marckwald, gave a lead of atomic weight 206·046, and was probably pure RaG, the last decay product of uranium; (3) bröggerit from Moos, Norway (also very old formation), free from heavy metals, containing 79 % U_3O_8, 4·5 ThO_2, 9·5 PbO, yielded a lead of atomic weight 206·063, like (2), therefore pure RaG. In addition a determination (4) was made of the atomic weight of common lead yielding 207·18 in agreement with T. W. Richards and Lembert, and with Baxter, Wilson, and Grover. Quartz vessels were used for distillations. The arc and spark spectra of (2) and (4) (reproduced in the paper) proved identical. The conclusion is that RaG is really an isotope of lead. H. B.

447. *Branching of the Thorium Series.* **S. Loria.** (Phys. Zeits. 16. pp. 6–9, Jan. 1, 1916.)—This paper commences with a brief outline of the various suggestions proposed for the scheme of disintegration of the thorium series—with special consideration of the point at which the "branch" occurs in this rather complex scheme. The work of Marsden and Barratt [see Abs. 686 (1912)], Marsden and Darwin [Abs. 1714 (1912)], Meitner [Abs. 1715 (1912)], and of Barratt and Wood [Abs. 188 (1915)], is reviewed. The scheme proposed by Barratt and Wood was suggested as a result of their experiments on the volatilisation of thorium active deposit. These experiments have been repeated by the author and the observations confirmed. Similar results have also been obtained with Ra active deposit. The interpretation of results given by Barratt and Wood is criticised and modifications based on the isotope theory, are suggested. A. B. W.

448. *Distribution of Thorium Active Deposit in an Electric Field.* **G. H. Henderson.** (Nova Scotian Inst. of Sci., Proc. and Trans. 14. pp. 1–16, Oct. 14, 1915.)—The paper commences with a brief review of earlier work on this and similar subjects. The work of Rutherford [Abs. 1198 (1903)], Russ [Abs. 1487 (1906)], Kennedy, Walmsley [Abs. 101 (1914)], and others, is discussed and criticised from an experimental standpoint.

The author has developed a new type of vessel for this kind of work. It is shown that in dry air all the thorium "rest-atoms" are positively charged initially. In pure ether-vapour all these atoms are initially uncharged, and in a mixture of ether-vapour and air the charged condition of the rest-atoms depends on the relative amounts of ether-vapour and air present. A similar state of affairs appears to be true with water-vapour. A. B. W.

449. *Radio-activity of Minerals. I. Pyromorphite.* **M. Bamberger** and **G. Weissenberger.** (Monatsh. d. Chemie, 36. pp. 169–174, 1915.)—An examination by radio-active methods of the Ra and Th contents of pyromorphite from various sources showed that whereas the Ra content varied considerably for different specimens ($1·8 \times 10^{-9}$ to 8×10^{-12} gm. Ra per gm. of mineral), the Th-content was more constant ($1·2 \times 10^{-4}$ to $1·8 \times 10^{-5}$ gm. Th per gm.). The mineral was shown to be homogeneous as regards its Ra-content, by dissolving the superficial layers of a crystal, and comparing the radium contents of the dissolved and undissolved portions, no difference being detected. It is shown that Danne's view that a surface concentration of Ra on the mineral had occurred from percolating water containing Ra is not tenable. Pyromorphite is regarded as a young formation, in which the Ra deposited at the time of formation from the water in which the mineral was formed has not completely decayed, whereas the mesothorium deposited at the same time has completely decayed, leaving only the minute quantity of Th deposited with the mineral. This accounts for the great variation in the Ra-content and the comparative constancy of the Th-content.
A. B. W.

450. *Radio-activity of the Deposits of the Eugenie and Ekaterine Springs in Borschom.* **E. Burkser.** (Russian Physico-Chem. Soc., J. 47. pp. 21–25, 1915.)—These springs form reddish-brown deposits consisting principally of hydrated ferric carbonate, together with 4·7 % and 84·1 % respectively of clay insoluble in dilute hydrochloric acid. In both cases radium and thorium (or mesothorium) emanations are present, the proportions found being $10·08 \times 10^{-12}$ and $26·2 \times 10^{-5}$ gm. respectively per gm. for the deposit of the Eugenie spring, and $17·89 \times 10^{-12}$ and $8·26 \times 10^{-5}$ gm. respectively for that of the Ekaterine spring. The water of the former spring contains $0·02 \times 10^{-9}$ gm. of Ra per litre, and that of the latter $0·07 \times 10^{-9}$ gm.; the Th-contents of the two waters are almost identical, and do not exceed $7·02 \times 10^{-4}$ gm. per litre. T. H. P.

451. *Variation of Emanation Content of Springs.* **R. R. Ramsey.** (Indiana Acad. Sci., Proc. p. 489, 1914.)—An examination of the variation of the emanation content of certain springs, shows roughly that an increase coincides with a season of rain and a decrease with dry weather. A. B. W.

HEAT.

452. *Testing of Thermometers at the Reichsanstalt.* **E. Warburg.** (Ann. d. Physik, 48. 8. pp. 1084–1088, Feb. 1, 1916.)—From April 1, 1916, onwards thermometers and pyrometers will be tested at the Reichsanstalt against a standard platinum thermometer scaled according to the law $R=R_0(1+at-bt^2)$. For temperatures between the melting-point of Hg and the boiling-point of S, the fixed points of calibration are 0° C., 100° C., and the boiling-point of sulphur, viz. $444{\cdot}55° + 0{\cdot}0908\,(p-760) - 0{\cdot}000047\,(p-760)^2$. For temperatures below the melting-point of Hg the fixed points are the boiling-point of CO_2, viz. $-78{\cdot}5° + 0{\cdot}01595\,(p-760) - 0{\cdot}000011\,(p-760)^2$, and of oxygen, viz. $-183{\cdot}0° + 0{\cdot}01258\,(p-760) - 0{\cdot}0000079\,(p-760)^2$. Above the boiling-point of sulphur the fixed points are the melting-points of Sb (630°), Au (1063°), and Pd (1557°). The scale thus established agrees, within the limits of experimental error, with the radiation scale given by—

$$\log_e H_2/H_1 = (c/\lambda)[(273+t_1)^{-1}-(273+t_2)^{-1}],$$

where H is the brightness of a black body at temperature t, λ is the wave-length (μ), and $c = 14{,}300$. J. W. T. W.

453. *Interpolation Formula for Resistance Thermometry at Low Temperatures.* **F. Zernike.** (K. Akad. Amsterdam, Proc. 18. 6. pp. 914–925, 1916.)—One of the difficulties of accurate low-temperature thermometry is the fact that the resistance is not a simple function of the temperature, so that linear interpolation is impossible even in small intervals, and for larger intervals neither quadratic interpolation nor graphical methods are of much use if accuracy to 0·02 deg. is required. It appears that for high temperatures the resistance is proportional to T, while for lower temperatures it is proportional to T^4. The author therefore uses an expression of the form $W - w = 100/(at^{-1} + bt^{-2} + ct^{-3} + dt^{-4})$, in which $t = 0{\cdot}01\,T$, where T is the temperature, while a, b, c, d, are constants; w is a constant depending on the purity of the metal. The third approximation to the values of the constants was made by the method of least squares, the final values obtained for Pt being $w = 1{\cdot}2487$, $a = 1{\cdot}8849$, $b = 0{\cdot}2695$, $c = 0{\cdot}2365$, $d = 0{\cdot}1806$. By means of this formula all temperatures below 200° are represented to within the errors of observation in gas thermometry, viz. 0·02 deg. The constants obtained for Au and Hg are given in the paper, although the accuracy of the formula in these cases is necessarily less owing to the comparatively small amount of data available. J. W. T. W.

454. *The Inner Cone of divided Hydrocarbon Flames.* **N. Bubnoff.** (Zeits. Phys. Chem. 88. pp. 641–669, Nov. 10, 1914.)—Haber and later Hiller (Ibid. 81. p. 591) had shown that the temperatures of calorimetric calculations were higher than those deduced from the water-gas constant. These discrepancies of 150 deg. and more disappear partly when Bjerrum's corrections for the specific heats of Pier are accepted; but they amount to 500 deg. for the CO-oxyhydrogen flame. Many of the experiments had been influenced by the assumption that the reacting gases would instantaneously be quenched and the reactions be stopped, if the gases were withdrawn from the flames through cooled silver capillaries. The new experiments were made on the inner cones of flames of benzene or ether (commercially pure) and coal gas. By adding nitrogen to the air, the flames were sometimes cooled by 150 deg. and more, and the dissociation of CO_2 was thus prevented. The results confirm the view that the calorimetric temperatures are too high, probably for the following reason. Especially in cool flames the oxygen is not really in thermodynamical equilibrium; owing to a certain sluggishness in the combustion, the oxygen concentration is greater than it should be according to equilibrium conditions; and the true temperature of the flame must be lower than that calculated from the amount of oxygen present. The calorimetric calculation of the temperature according to Bjerrum's specific heats gives, moreover, too high values because the heat losses, arising in flames from radiation and conduction, do not enter. The arguments do not affect the deduction of temperatures from the water-gas constant, though it might be thought that the components of the water-gas reaction might not be in equilibrium in the flame either; but optical and thermoelectric tests gave the same values for gas charges differing in composition ratios.

Note added by **F. Haber** (Ibid. p. 670).—The two chief results of the research are that the oxygen is not, in the inner cone, in equilibrium with the CO_2 and CO and that the composition of the mixture of ether (or benzene) and air is not the same at the base and at the apex. The relatively denser constituent becomes concentrated near the apex. This peculiar feature has further been investigated by Haber and Y. Kauko by preventing all penetration of alien gas into the cone. The benzene remained concentrated at the apex, whilst the hydrogen (in the hydrogen-air flame) became impoverished at the apex. Thus a certain de-mixing takes place in the flame, the lighter component collecting at the side, the heavier near the apex. H. B.

455. *Combustion in the Inner Cone of the Bunsen Flame.* **L. Ubbelohde and O. Dommer.** (J. für Gasbeleuchtung, 57. pp. 757–765, Aug. 1; 781–787, Aug. 8, and pp. 805–810, Aug. 15, 1914. Chem. Zentralblatt, II. pp. 1879–1880, 1914.)—In all gas-air flames investigated the dissociation-equilibrium both of CO_2 and of aqueous vapour is not found established immediately above the inner cone and the equilibrium is most incomplete in CO-air mixtures. Using stoichiometric mixtures the thermodynamic temperature and the thermo-couple temperatures differ by 500 deg. in the CO-flame, by 200 deg. in the CHg flame, by 180 deg. with acetylene, and by about 70 deg. with hydrogen and coal-gas flames. About 20 % of the CO-oxygen mixture escapes unburnt from the inner cone, and begins to react only outside that cone, the reaction being trimolecular and much slower than on the surface of the cone. The equilibrium is very much more quickly established when the air is rich in oxygen or when the mixture is preheated, because the velocity of ignition is increased; platinum and incandescence burners also catalyse the combustion. The measured temperatures (thermo-couples) do not at all agree with Pier's calorific and specific heat values in the case of CO-flames; in the case of the hydrogen flame, the difference is only 4 %. For this reason probably the hydrogen flame is, against expectation, hotter than the CO-flame, and mixtures of coal-gas and hydrogen give hotter flames than coalgas-CO mixtures. The addition of 7 or 10 % of water-vapour increases the velocity of ignition of CO-flames threefold; with 1 % of water-vapour the temperature of ignition is lowest. Methane is incompletely burned in the inner cone; some methane is probably formed in the first combustion of acetylene and ether-flames and escapes as such from the cone. The aureole can in CO-flames be observed at temperatures 500 deg. below ignition and is probably due to an after-combustion in the intermediate gas. H. B.

456. *Flames.* **A. Reis.** (Zeits. Phys. Chem. 88. pp. 513–568, Oct. 13, 1914.)—General considerations on flames based upon the assumption of Haber that a purely thermal definite emission and absorption of light and a definite velocity of reaction are characteristic of all gases of definite composition and temperature, and an account of further experiments on the introduction of simple, inert compounds (ammonia, cyanogen, etc.) with flames of pre-mixed gases (Bunsen burners) or split flames (Teclu, Smithells). The investigation concerns in particular flames of ammonia-oxygen, cyanogen-oxygen and cyanogen-air, the quantitative reactions in the inner cones and intermediate gases (between the two cones) and the spectra of the separated zones; photographs of these new spectra (Hilger quartz spectrograph) are reproduced. Ammonia-oxygen mixtures are explosive when they contain more than 80 or less than 15 % of ammonia. The temperatures in the intermediate zone above the cone are: 1 mm. above, 1830°; 2 mm. 1670°; 10 mm. 1400°; 33 mm., 1000°; 63 mm., 815°. The decomposition of the ammonia in this zone is not thermal in nature, and the velocity of the reaction decreases surprisingly little on cooling; this also holds for the intermediate zone in the cyanogen-oxygen flame, and the cases would be analogous to that of the inner cone of the Bunsen flame, from which the intermediate gas issues in the condition of water-gas as equilibrium. The products of combustion in the inner cone of the cyanogen-oxygen flame being diatomic, the flame differs from others; it has an unusually high temperature and its spectrum resembles that of the carbon arc. In the presence of an excess of oxygen, the spectrum is discontinuous (water-gas); when there is an excess of cyanogen, the water-gas spectrum is very weak, but the Swan spectrum [carbon bands] and cyanogen spectrum become intense. So far as the introduction of hydrogen into the flame indicates, the presence of water-vapour does not appear to affect the light emission of the cyanogen-oxygen flame. As regards the co-ordination of the spectra and certain compounds, only one of the bands of the ammonia-oxygen flame seems to belong to ammonia. That the Swan spectrum is connected with carbon vapours is further proved by a study of the acetylene-oxygen flame, in which carbon vapours (probably molecules of many atoms) appear. The spectra of burning hydrocarbons (Eder spectra) and certain nitrogen spectra only appear during actual combustion; the water-gas spectrum, on the other hand, seems in hot flames to be emitted also by the intermediate gases; but the co-ordination of this spectrum requires further investigation. It has to be borne in mind that the inner cone can only be observed through the zone of intermediate gas. [See also Abs. 465 (1914).] H. B.

457. *Cosine Law in Kinetic Theory of Gases.* **M. Knudsen.** (Ann. d. Physik, 48. 8. pp. 1113–1121, Feb. 1, 1916.)—By apparatus shown in diagrams this law has been experimentally tested, and the result is in agreement with the law. E. H. B.

SOUND.

458. *Propagation of Sound in the Atmosphere.* **E. van Everdingen.** (K. Akad. Amsterdam, Proc. 18. 6. pp. 938–960, 1916.)—In various investigations on the propagation over great distances of sounds from intense sources, especially in the case of volcanic eruptions and explosions, deviations have been found, partly regular, partly irregular. The source of sound is always surrounded by an area of regular or irregular shape, where the sound is heard everywhere, but the source is far from being always situated symmetrically within this area, and the dimensions of the latter are not even in the first place determined by the intensity of the sound. In many cases a second area of audibility occurs, separated from the first by a region where no sound at all is heard. Sometimes this second area partly surrounds the first, sometimes it consists only of isolated spots. It can be said generally that the smallest distance from the source of sound for this second area is usually much more than 100 km., and that the intensity of sound at this smallest distance is no smaller than at the outer border of the first area of audibility, which is much nearer to the source of sound. These facts are illustrated by diagrams of seven different cases which have previously been investigated. These are as follows :—(1) Explosion of 15,000 kg. of dynamite at Färde in Westphalen, Dec. 14, 1908 [G. van der Borne, Abs. 106 (1911)]. (2) Explosion of 25,000 kg. of dynamite near the Jungfrau railway, Nov. 15, 1908 (A. de Quervain). (3) Three eruptions of the volcano Asama in Japan, on Dec. 7, 1900; Dec. 25, 1910; and April 4, 1911 (F. Fujiwhara). (4) Explosion of gunpowder and dynamite at Kobe, April 3, 1910 (S. Fujiwhara). (5) Explosion of 200,000 kg. of gunpowder in a magazine at Wiener-Neustadt on June 7, 1912 [J. N. Dörr, Abs. 1295 (1914)].

Two chief lines have been followed in the endeavour to explain these facts. The first way, now quite old, ascribes the abnormal propagation of sound to the influence of variations in temperature and wind-velocity in the superposed layers of air in the atmosphere. It is easy to see how, by certain suppositions about the vertical distribution of wind-velocity, peculiarities of the propagation of sound, especially the silent region, may be explained. The influence of temperature, which decreases upwards, is a decrease of the velocity of sound in the higher regions, thus causing the sound rays to curve upwards from the earth. A horizontal wind in the direction of the sound, and with higher velocities at higher levels, may counteract the above temperature effect and overcome it, so turning the rays down again to the earth. A silent region followed by a second audible area is thus accounted for.

The second and entirely different line of thought was put forward by von der Borne. He supposes that the appearance of silent regions, in some cases at least, may be due to the change in composition of the atmosphere, which is caused by the unequal decrease of the partial pressures of the constituents of the atmosphere. If no mixing by convection currents occurred, each of the gaseous constituents of the atmosphere would form an atmosphere entirely according to its own laws. In consequence of this at great heights the denser gases could only occur as a very small percentage, and the lighter constituents, of which hydrogen is the most generally known, must gradually begin to predominate. The convection currents alter this state of things only so far as the lower atmosphere (the troposphere) is concerned. Above 10 or 11 km. (at least in the temperate zone) little convection occurs, and above this level the change of composition is expected to begin. Also above that same level the fall of temperature with height ceases. As the velocity of sound in hydrogen is much greater than that in nitrogen or oxygen, it follows from this that at very great heights the velocity of sound increases so much that the sound rays are curved towards the earth.

In the light of these two competing theories the present author considers the following eight cases which have occurred during the present war :— (1) Bombardment of Antwerp, Oct. 7–9, 1914 ; (2) naval battle on the North Sea, Oct. 17 ; (3) bombardment of German positions on the Yser by British naval guns, Oct. 18 ; (4) heavy fighting on the line Ostend–Nieuport–Ypres, Oct. 22 ; (5) heavy fighting at the Yser canal, east of Ypres and south of Lille, Oct. 24 ; (6) bombardment of German artillery in Flanders by 12-in. British naval guns, Oct. 28 ; (7) severe attack of Germans on Ypres, British naval guns in action, heavy fighting at Dixmuiden, on the Lys, and at Messines ; (8) naval battle on the North Sea, Jan. 24, 1915. These cases are illustrated by maps and an elaborate table of the meteorological conditions at the times in question. Reviewing these cases, the author notes that the silent region is often displayed and in the siege of Antwerp in an extraordinarily regular form.

Of the two explanatory theories put forward the influence of variations of wind and temperature with height leads us to expect an asymmetry with respect to the source of sound and a difference between two mutually perpendicular directions, and permits of all kinds of distances. The physical explanation, on the other hand, requires complete symmetry with respect to the source of sound. It is found that the outer limit of the silent region is only slightly changed by considerable irregularities in the distribution of wind or temperature.

Probably many of the cases observed are explicable on the meteorological theory, although there is not absolute proof of this. In favour of the physical theory it must be noted that the border of the silent region has been always at about 160 km. from the probable source of sound and that no appreciable deviations from the circular form have been found. E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

459. *Electric Energy Density and Wave Conditions in Electrically Unexcitable Bodies.* **K. Uller.** (Phys. Zeits. 16. pp. 409–414, Nov. 15, 1915.)—A mathematical paper which cannot be abstracted. The electrically unexcitable bodies are those (metals and metalloids) in which the real part ϵ' of the "exciting coefficient" ϵ (which latter was previously called "complex dielectric constant"), turns out negative. L. H. W.

460. *Spontaneous Ionisation of the Aqueous Vapour of the Atmosphere.* II. **G. Oddo.** (Soc. Chim. Ital., Gazz. 45. 1. pp. 395–412, 1915.)—The author discusses the various views which have been expressed concerning the origin of atmospheric electricity, this being connected largely, if not entirely, with the presence of water-vapour. The molecules of the latter, being in a rarefied or diluted state, undergo spontaneous ionisation in the same way as do electrolytes in dilute aqueous solution; the ionised aqueous vapour of the atmosphere acts, therefore, as a conductor of the second class. In comparison with this source of ions, all other sources, such as the actions of ultraviolet radiation from the sun and of terrestrial radio-active substances, etc. must be regarded as subsidiary.

From the specific humidity of the air, the number of molecules contained in one gm.-mol. of a gas, and the number of ions formed from 100 mols. of water at different temperatures, the ionic concentration is calculated for various temperatures and pressures. Fall of temperature diminishes the proportion of water-vapour in the air, but, starting from 32°, increases its degree of ionisation. The calculations now made show that the ionic concentration, C_1, is highest and approximately constant between 5° and 20°; it remains high even at —10°, but diminishes rapidly between —10° and —20°, in spite of the rapid increase in the degree of ionisation; it is also high at 25°, decreasing rapidly at higher temperatures, and becoming virtually zero at 32°. With varying pressure, the ionic concentration changes nearly in accordance with Boyle's law, $p \,.\, C_1 = K$. It will be seen that the ionic concentration of the atmosphere is at its maximum for those conditions of temperature which are most suitable to animal and vegetable life, and it may be assumed that the latter constitutes a true indicator of this ionic concentration.

At 15° and a pressure of 760 mm., 1 kg. of moist air, occupying 778·4 litres at 0° and 760 mm. in the dry state, contains 89×10^{-20} hydrogen and hydroxyl ions, and such marked ionisation would lead to the supposition that many processes of oxidation and reduction, occurring in contact with air, are electrolytic in character. A number of natural processes of the inorganic, vegetable, and animal kingdom are discussed on these lines. T. H. P.

DISCHARGE AND OSCILLATIONS.

461. *True Absorption of Canal Rays.* **W. Wien.** (Ann. d. Physik, 48. 8. pp. 1089–1097, Feb. 1, 1916.)—In the absorption of canal rays a distinction must be made between the enfeebling of the bundle of rays by scattering and by actual absorption. The former action consists only in an alteration of the direction of the motion of the particles, while by the absorption proper, here called "true absorption," the rays lose their velocity and with it their characteristic properties. The true absorption of canal rays is of especial interest, because, being the action of a certain kind of collision of particles of matter, it gives an insight into the mechanism of the whole molecular theory. It is very difficult to observe the true absorption by the photographic method, but it is found that the observations can be satisfactorily made by measuring the heat produced. The thermo-element employed, and the method of carrying out the experiments are described in detail. In spite of the deviations shown in the results obtained, it is quite clear that the absorption coefficient is not proportional to the pressure. The probable sources of error are considered. Tables are given showing the absorption coefficients at different pressures in nitrogen and in oxygen. A. E. G.

462. *Arcs between Non-vaporising Electrodes.* **G. M. J. Mackay** and **C. V. Ferguson.** (Frank. Inst., J. 181. pp. 209–216, Feb., 1916.)—In this note the author indicates briefly the nature of some experiments, to be more fully described later, made during an investigation of the rectifying properties of gases. Langmuir's work [Abs. 725 (1914)] upon the emission of electrons from an incandescent filament *in vacuo* has been extended to gases at comparatively high pressures. By the use of tungsten electrodes it has been found possible to construct enclosed arcs which will act as rectifiers of alternating current and carry 10 to 20 amps. with a life of many hundreds of hours. The electrodes operate at temperatures between 2600° and 3200° K., and there appears to be no more loss of material than can be accounted for by the normal rate of evaporation of the tungsten at these temperatures. If the pressure of the gas is of the order of several cm. or higher there is no trace of kathode sputtering. The reasons for its absence seem to be: (1) elimination of high kathode drop by a uniformly highly heated electrode, and (2) a comparatively high pressure of gas, which lowers the kathode drop, by lessening the mean free path of the impinging positive ions, and also lowers the rate of evaporation of the hot metal. The hot kathode used could be heated by a current of 20 amps. to 2800° K.; the anode was large. The volt-amp. characteristic of hydrogen was of the ordinary form showing an unstable portion when the discharge changes with increasing current from an almost invisible glow to a very concentrated arc. Other gases such as nitrogen or argon did not show such well-defined points of instability. If the characteristics of the arc are affected to any extent by the evaporation of electrode material, as has been supposed with carbon and low-boiling-point metal electrodes, it should be expected that strikingly different results would be obtained with the tungsten arc. Since such differences have not been found, and since many arcs have shown no spectroscopic evidence of the pressure of tungsten, it would appear that rapid evaporation plays no necessary part in the conduction. With direct current the nature of the anode had no appreciable influence.

Oscillographs are given showing the behaviour of an a.c. arc in hydrogen, nitrogen, argon, and air. I. W.

463. *Negative Resistance.* **A. W. Hull.** (Phys. Rev. 7. pp. 141–143, Jan., 1916. Paper read before the Am. Phys. Soc. Oct. 30, 1915.)—When electrons fall on a metal plate in vacuum they cause the emission of secondary electrons (δ-rays). This emission increases with the velocity of the bombarding electrons up to a certain value of the velocity, above which the metal plate loses electrons instead of gaining them. If the primary electrons come from a hot filament, and their velocity is due to the voltage difference between the filament and the plate, it is possible that increased voltage may cause a decreased current to the plate. Under these conditions the system consisting of the filament and plate acts as if it had a negative resistance.

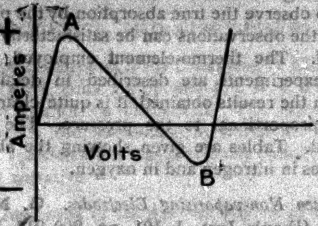


FIG. 1.

The secondary electrons have too low a velocity to reach the filament against the opposing potential, and so it is necessary to provide a third perforated conductor more positive than the plate to catch the secondary electrons. Fig. 1 shows the characteristic of a tube of the kind referred to. The portion AB is the region of negative resistance, the current being considered as positive when positive electricity flows from high to low potential across the evacuated space. The negative resistance is reversible, has no lag, and is aperiodic. Fig 2 shows a tube connected in series with a resistance R. If the tube has a negative resistance *r*, a small change of the voltage across the two resistances will cause the voltage across R to vary $R/(R-r)$ times the amount of the variation. This method may be used to obtain 10,000-fold voltage amplification. A. J. M.

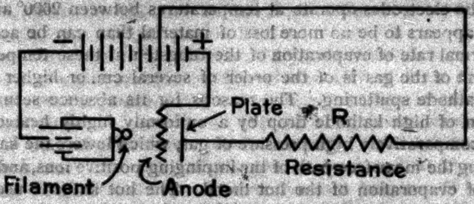
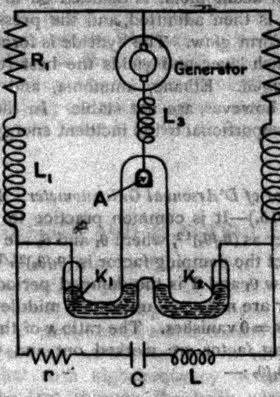


FIG. 2.

464. *Electrical Oscillations from Mercury-vapour Tubes.* **B. Liebowitz.** (Phys. Rev. 6. pp. 450–477, Dec., 1915. El. World, 67. pp. 385–386, Feb. 12, 1916.)—The types of arc oscillations have been classified by Nasmyth [Abs. 825B (1911)] as "Duddell," "Poulsen," and "Wien" oscillations. These types are characterised respectively by a condenser current of smaller amplitude than the direct current, a condenser discharge in the form of a single undirectional pulse, and a discharge in the form of a damped oscillation. The object of the experiments and mathematical investigation is to determine whether it is possible to obtain oscillations of the last two types by means of mercury-vapour tubes. Preliminary experiments with a 750-volt supply gave negative results although irregular pulsations were obtained. This failure is ascribed partly to the distributed capacity of the windings of

the series inductance coils, and further reasons for the failure are deduced by mathematical reasoning. It is shown that the counter-e.m.f. P of an oscillating arc is given by $P = (v_0 + v_1)/[2(1 + K)]$, where $K = t_1/t_0$ or the ratio of the time during which the tube is in a conducting state to the time during which the tube is in a non-conducting state and v_1 and v_0 are the instantaneous condenser e.m.f.'s at the ends of the periods t_1 and t_0. The oscillations are stable if the mean value of the supply current is greater than half its steady value with short-circuited arc if a constant supply voltage be used and if the supply voltage is greater than 2P, but stability can be obtained at smaller values of the current if the e.m.f. used



decreases rapidly with increase of current and follows the changes of the current almost instantaneously, as otherwise the current will fall below its critical value for a period long enough to cause the extinction of the arc. From these facts it is argued that to obtain stable oscillations the impressed voltage must be not less than several thousand volts; that the series inductance must be not less than several henries, and that the ratio L/C of the inductance to the capacity of the oscillatory circuit should be as large as possible. Experiments made with conditions meeting these requirements as nearly as possible and with a supply pressure of 4000 volts were again found to have negative results as it was not possible to increase the ratio L/C sufficiently to give steady oscillations with the available supply voltage. It was found that steady oscillations could be obtained with a mercury-vapour tube with two Hg kathodes K_1 and K_2 and a single iron or graphite anode A, the oscillation branch r, C, L being connected across the two kathodes as shown in the Fig. The oscillations generated were of variable amplitude and the frequency of the amplitude variations was above audibility. The ratio L/C was taken between 10^7 and 10^8 with capacities C ranging from 0·002 to 0·0002 mfd., and the supply was given by a 4000-volt generator. The values of the series inductances were L_1, L_2, and $L_3 = 1·78$, 1·71, and 0·21 henry respectively. The oscillations produced had frequencies ranging from 50,0000 to 80,000 cycles per sec., and the high-frequency output was about 50 watts with 88 ohms in the oscillatory branch. The oscillations pass directly between the two kathodes and the anode carries the d.c. discharge only.

A. J. M

ELECTRICAL PROPERTIES AND INSTRUMENTS.

465. *Sensitive Photoelectric Cells.* **J. Kunz** and **J. Stebbins.** (Phys. Rev. 7. pp. 62–65, Jan., 1916.)—In view of the successful employment of alkalihydride photoelectric cells to stellar photometry [Abs. 1627 (1913)] several new forms have been tried. The final form consists of a glass bulb 8·4 cm. in diam. containing a small Pt kathode and an anode consisting of a Pt ring 1·8 cm. in diam., the stalk of which passes through a Pt cylinder whose function is to lead surface and electrolytic currents of the glass to earth. The sensitive surface consists of a silver mirror kathode which is cooled by ice, while an alkali metal is distilled on to it in a thin uniform layer. Pure hydrogen is then admitted, and the pressure so adjusted that 800 volts produce a uniform glow. The hydride is formed in a few seconds. Rubidium gives a reddish layer, and yields the best results, especially with neon instead of hydrogen. Ethane, ammonia, and acetylene give very sensitive layers, which, however, are not stable. In the rubidium-neon cell the current is exactly proportional to the incident energy. No current values are quoted. E. E. F.

466. *Damping Factor of D'Arsonval Galvanometer.* **L. Pyle.** (Phys. Rev. 6. pp. 446–449, Dec., 1915.)—It is common practice to express the damping factor of a galvanometer as $(\theta_1/\theta_2)^{1/2}$, where θ_1 and θ_2 are the first positive and negative throws. In fact the damping factor is $(\theta_1/\theta_2)^{2t_1/T}$, where t_1 is the time taken to attain the throw θ_1 and T is the damped period. These two values for the damping factor are not equal unless the middle term of the equation of motion $K\ddot{\theta} + a\dot{\theta} + b\theta = 0$ vanishes. The ratio x of the latter to the former values for the damping factor are worked out and the following values obtained in terms of θ_1/θ_2:—

θ_1/θ_2 1	1·5	3	5	8	10
x 1	0·9836	0·8890	0·7846	0·6791	0·6291

These values are corroborated by a test made with a ballistic galvanometer with variable damping, oscillograms being described photographically by a beam of light from the mirror of the oscillating coil falling on a rotating drum. A. J. M.

ALTERNATING CURRENTS AND MAGNETISM.

467. *Electron Theory of Paramagnetism.* **J. Kroo.** (Deutsch. Phys. Gesell., Verh. 17. 24. pp. 452–468, Dec. 30, 1915.)—Starting with Born and Karman's space-lattice theory the author obtains an expression for the magnetic moment and, on applying the Lorentz-Wien theory of collisions, for the specific susceptibility. The results on this theory for Pd and Pt are then compared with those obtained by Onnes and Oosterhuis. It is considered that the theory correctly explains the general behaviour in a qualitative sense although it is only a first attempt. A relation between resistivity and susceptibility would appear to be revealed by this theory. L. H. W.

468. *Lord Kelvin and Terrestrial Magnetism.* **C. Chree.** (Inst. El. Eng., J. 54. pp. 405–425, March 1, 1916. Seventh Kelvin Lecture.)—The author traces the influence of the practical and theoretical work of Kelvin on the progress and utilisation of our knowledge of terrestrial magnetism. Of the outstanding problems special attention is devoted to secular change, solar diurnal variation, and the phenomena of magnetic disturbances. The secular change is shown from 1580 to 1914. In the discussion of diurnal variations comparisons are shown graphically between the diurnal inequalities at Kew and those from the results of the National Antarctic Expedition, the diagrams being plotted as vectors for each hour of the day, showing separately the values for selected quiet days and all days. An interesting difference between the two records is that the azimuth of the force producing the difference between quiet and all-day phenomena at Kew is practically constant at 64° East of North, while that for the Antarctic swings round through all azimuths during the 24 hours. It is also noted that the azimuth of the non-cyclic effects in the horizontal components at Kew, treated as a vector, comes perpendicular to the azimuth of 64° East found for the above-mentioned effect. A long discussion is given of the phenomena of magnetic disturbances, chiefly with respect to the 27-day period as indicating solar influence. C. P. B.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

469. *Electrical Conductivity of the Human Body.* **G. Bucky.** (Elektrot. Zeits. 36. pp. 673–675, Dec. 23, 1915.)—This article discusses the resistance of the human body from the medical point of view. The conductivity of the different tissues and of complicated arrangements of these tissues must be taken into account, and the author endeavours to give reasons in explanation of the fact that with high-frequency treatment, currents of more than 3 amps. can be sent through the body without injury, and this is supposed to be due to the absence of ionisation and of the dissociation of any salt solutions. The article is intended to set forth the principles on which suitable medical treatment can be prescribed for ordinary ailments and for accidental electric shock. W. H. S.

470. *The Production of X-rays in the Present War.* **U. Magini.** (Elettrotecnica, 3. pp. 126–133, March 5, 1916.)—This article is a critical review of the X-ray apparatus employed in Italy and abroad for war purposes. The author states that apparatus of medium power is mostly employed: powerful appartus is too expensive, too heavy, and difficult to transport. A general review of the different instruments constituting an X-ray apparatus, with a discussion of their merits and inconveniences, is given. The reasons for the adoption of induction coils and interrupters instead of ordinary transformers and alternating current are explained. The author considers that the solution of the two fundamental problems in the production of X-rays, namely, the increase of the efficiency and the elimination of the inverse currents, will probably be given by a tube with thermic ionisation, derived from the Coolidge type. This tube has, as a matter of fact, a high efficiency and acts rigorously as a valve. E. B.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

471. *Periodic System and Properties of the Elements.* **W. D. Harkins** and **R. E. Hall.** (Am. Chem. Soc., J. 88. pp. 169–221, Feb., 1916.)—The authors have evolved a periodic table which shows graphically the relations between the main and the sub-groups of elements. The elements are arranged in the exact order of their atomic numbers and there are no blanks for unknown elements not corresponding with atomic numbers as determined by Moseley's work on the X-ray spectroscopy of the elements. The elements are also plotted according to their atomic weights, so that the isotopic forms of an element may be shown graphically on the table, and the alpha and beta decompositions of the radio-active elements plainly depicted. Both the zero and the eighth groups fit naturally into the system. The table may be best represented as a helix in space, but may be shown as a spiral in a plane.
T. H. P.

472. *Molecular Attraction.* II. **K. K. Järvinen.** (Zeits. Phys. Chem. 88. pp. 428–450, Oct. 6, 1914.)—In his first paper (Ibid. 88. pp. 541–574), a general formula of the gravitation type was deduced by the author for the molecular attraction, $F = m^2k/r^n$. The second paper assumes $n = 5$, that is, $F = m^2k/r^5$, and compares the derived formulæ with observed values. The formula is found to hold, if the centres of the atoms be accepted as centres of attraction; in that case the molecular attraction would be $F = m^2k/(r - br_1)^5$, where r and r_1 are respectively the distances between molecules and their diameters and b is a constant. This formula leads to $C_a/W_i a$ = const., where C_a is that portion of the molecular specific heat wanted for overcoming the molecular attraction, and W_i the inner latent heat, which accords with experimental determinations if the theoretical values be taken for the constant, *i.e.* 1·29 for monatomic (assuming tetrahedral grouping of the molecules), and 1·68 for polyatomic substances. Further complex formulæ for the heat of vaporisation are shown to agree with accepted data even near the critical points. From these equations the constant k may be calculated; k is the greater, the smaller the density s of substance at its boiling-point, and for a large number of substances (the common gases, mercury, methane, hexane, benzene, etc.) ks is approximately constant; for many others, however, comprising most of the inorganic substances (Cl, I, Br, organic compounds containing these, anilines, S, H_2O, H_2S, SO_2, PCl_3, HNO_3) there is no constancy at all. These latter substances are probably associated or anomalous in other respects; that would have to be proved before the validity of these laws could be accepted. If valid, however, the molecular attraction between equal volumes of any substances would be the same, and that would point to a common original constituent of all the elements.
H. B.

473. *Structure of Slimy Crystalline Liquids.* **O. Lehmann.** (Ann. d. Physik, 48. 6. pp. 725–769, Dec. 7, 1915.)—The author discusses at great length the behaviour and properties of liquid crystals. He distinguishes three classes of such crystals—namely: (1) gluey liquid; (2) slimy liquid; (3) drop-forming liquid. The original pages should be referred to for details and the explanatory diagrams.
L. H. W.

474. *Palladium and Hydrogen.* II. **A. Sieverts.** (Zeits. Phys. Chem. 88. pp. 451–478, Oct. 6, 1914.)—Continuing his experiments (Ibid. 88. pp. 103–127) with the same materials (Pd-wires, palladium black, and spongy Pd, molten metal at 100° to 1500° C.) and the same apparatus, now between 138° and 821° and at pressures from 1 to 760 mm. of Hg, the author finds that the absorption of hydrogen, L_p, per unit weight of Pd-wire (pure or commercial) is roughly proportional, within the temperature limits stated, to $kp^{1/n}$, where p is the hydrogen pressure. But the ratio $L_p/p^{1/n}$ increases with increasing pressure, so that $L_p = k_1p^{1/n} + k_2p$, where k_1, k_2 are constants depending upon the temperature. Thus hydrogen molecules would appear to be in equilibrium with hydrogen atoms, both in the gas phase and when in solution in Pd, and Henry's law would hold strictly for atoms as well as for molecules. The dissociation constant of hydrogen calculated in this connection remained practically constant between 300° and 820° (values ranging from 102 to 112), but was smaller at 138° (25). The equation above given does not hold for higher pressures and does not explain the peculiar isothermals of Troost and Hautefeuille and of Hoitsema (determined in the seventies and nineties). Quantitatively the absorption seems to depend merely on temperature and pressure, not upon the exposed surface area, and would therefore be a true solution phenomenon. The isothermals for compact Pd and for palladium black and spongy Pd are similar though not identical, and the character of the metal (the mode of preparation of the specimens) has some influence. Above 100°, however, at any rate the hydrogen seems to be simply absorbed by the black metal or sponge; below 100° surface absorption plays a considerable part. The phenomena would be in accordance with the assumption that finely-divided Pd (black and sponge) is made up of different proportions of the amorphous and the crystalline metal, which have different powers of holding hydrogen in solution. On the other hand, the absorption isobars and isothermals of the system palladium-hydrogen do not support the view (of Andrew and Holt and of Halla) that an enantiomorphic transition of Pd should take place near 150°. H. B.

475. *Electron Emission during Chemical Reactions.* **G. Just** and **F. Haber.** (Zeits. Elektrochem. 20. pp. 483–485, Aug. 1, 1914.)—The continued experiments concern in particular the effect of illumination, by a candle or an arc lamp. The apparatus is joined to a Gaede pump and to a tube containing, within a thin glass capsule (to be broken by an electromagnet) some thionylchloride; the tube can be cooled by liquid air, so as to keep the vapour pressure very low. The other reacting substance is the liquid alloy K-Na, which drips from a silver capillary; below the outlet of the capillary is a ring of silver connected to an electrometer. The whole apparatus is wrapped with tin-foil, except a window through which the light can fall on the drops of metal. Neither the dripping, nor the escape of the thionyl alone affected the electrometer in the dark; a slight discharge of the electrometer was observed when the candle was approached, and the effect increased rapidly as the temperature of the (originally cooled) cell rose. The sum of the two single effects (reaction and light) was only one-tenth of the combined effects with candle-light, but half of the combined effects with arc illumination. Experiments were also made with the metals Cu, Ag, Al, which had to be heated to show any emission of electrons. This cell was further provided with a device to rub the metallic cap (heated by a coil) clean during the experiments with iodine or hydrogenchloride by means of a small electric motor and emery-wheel; the cell had to be made large to accommodate this device; the latter, however, was not really required. The metal was charged to 16 volts, positive or negative. Aluminium showed no discharge of the electrometer below 160°, when iodine vapour of —19° was admitted by turning a tap; at 180° the effect became distinct; at 240° it was very strong, especially when the metal was charged negatively. With positive charges the effects were much weaker. At high temperatures of the metal the discharge lost its unipolar character. H. B.

476. *Preparation of Zsigmondy's Colloidal Gold; Influence of Foreign Substances.* **K. Hiege.** (Zeits. Anorg. Chem. 91. pp. 145–185, Feb. 16, 1915.)—The colloidal gold solution of Zsigmondy, in whose laboratory this research was carried out, is prepared by mixing 6 gm. of $AuHCl_4,4H_2O$, dissolved in 1 litre of purest water, with K_2CO_3 and with from 8 to 5 cm.^{3} of formaldehyde solution. According to Tammann the spontaneous crystallisation, *i.e.* the formation of a colloidal solution, depends upon the formation of crystal centres or nuclei (this power he designates by K.V.), and upon the linear rate of advance (K.G.), temperature, etc., and the presence of foreign substances influence these factors. The author studies the water (for ultramicroscopic examination), and the solutions before and after adding the formaldehyde, examining the influence of many colloids (several oils, fats, soaps, gum arabic, SiO_2, SnO_2, F_2O_3, etc.), and of a very large number of electrolytes, some of which (alkali halides) act in the first instance favourably on the formation of nuclei, but may, like colloids, hinder it in two ways, by uniting with the gold particles, and by their carrying electric charges (ferric oxide). Some organic compounds reduce the gold before addition of the formaldehyde. The concentrations of electrolytes, required to cause coagulation, are likewise tabulated. The protective colloids, gelatin, sodium soaps, and protalbate, sulphur, stannic acid, silicic acid (the latter especially if "aged," when probably contaminated with organic matter) prevent the formation of nuclei, particularly at certain concentrations; in smaller concentrations they may cause turbidity, which disappears on adding more colloid; at that moment the number of nuclei is a minimum. Always injurious are the ferrous and ferric potassium cyanides, and slightly less so the colloidal metallic oxides (Sn, Fe, Co); for this reason, probably, ordinary water is unsuitable. H. B.

477. *Heat Losses from an Electric Steel Furnace.* **W. H. Wills** and **A. H. Schuyler.** (Am. Electrochem. Soc., Trans. 28. pp. 207–216; Disc., 216–220, 1915.)—Experiments, two runs of about 4 hours each, made under ordinary working conditions, on a 2-ton Héroult furnace of the Treadwell Engineering Co., especially to determine the heat losses due to gases issuing from the two charging doors and the tap-hole between them (first run) and the heat-losses by conduction into the electrodes and by their water-jackets (second run). Sheet-iron flues were fitted over the doors and tap-hole, thermo-couples were pressed tightly against the three graphite electrodes (three-phase), and the cooling water temperatures were taken; the jackets are on the top of the roof. Little gas was generated, but there was an indraught of air through the badly closing doors. The average heat losses amounted to 12·5 % (doors and tap-hole), and 7·8 % (electrodes) of the power put into the furnace; the former loss might have been reduced considerably, the latter hardly. In the *discussion,* **C. Hering** and **L. Addicks** criticised the flues, which acted as chimneys, and the electrodes, which they considered too large; **J. W. Richards** did not consider the losses unusual. The furnace had been used for four years. H. B.

478. *Preparation of Aluminium from Russian Minerals.* **N. Puschin, E. Dischler, and M. Maksimenko.** (Russian Physico-Chem. Soc., J. 46. pp. 1847–1865, 1914.)—When a current density of 2–3 amps./cm.^{2} of the anode surface, and a fused mixture containing about 40 mol. % of aluminium fluoride are employed, and alumina is periodically added to the mixture, the extraction of Al may be carried on continuously for a long time, the yield approximating to that obtained in large industrial plant. Aluminium may be prepared from the simonite found in the Urals, the mineral being converted first into the oxide and then into the oxyfluoride, Al_2OF_4, which is found to be more suitable than the fluoride for treatment in the electric furnace.

T. H. P.

479. *Emission of Corpuscles during Chemical Reactions.* I. **S. Tanatar and E. Burkser.** (Russian Physico-Chem. Soc., J. 47. pp. 956–958, 1915.)—The apparatus employed consisted of an electroscope with Al leaves, which in most cases were charged positively to about 200 volts. By means of a scale and mirror, the rate of discharge was measured, first in presence of the substances to be used in the reaction, and subsequently during the reaction. (1) *Reactions in which no gases are evolved*: with the neutralisation of concentrated sodium hydroxide solution by concentrated sulphuric acid, the oxidation of concentrated sodium sulphite solution by permanganate, and the oxidation of alcohol by potassium dichromate and sulphuric acid, no ionisation was observed. With potassium ferrocyanide and hydrogen peroxide, or ammonia and nitric acid vapours, or ammonia and CO_2, feeble ionisation occurred, and with ammonia and SO_2 marked ionisation. With ammonia and hydrogen chloride, evolved from their concentrated solutions placed on the bottom of the containing cylinder, the ionisation was intense, the dispersion of the charge proceeding at the rate of 10 volts per min., and the effect being observable more than an hour after the introduction of the solutions; when the electroscope was charged negatively, the ionisation was considerably less marked.

(2) *Reactions in which gases are evolved*: no ionisation is observed with sulphuric acid and sodium carbonate or sulphite solution, quinol and a mixture of sulphuric acid and permanganate, or concentrated solutions of sodium hydroxide and ammonium chloride. Ionisation occurs with the reactions between sodium amalgam and water, and between potassium ferricyanide and barium peroxide (1 volt per min.). The ionisation is more marked with formic acid and sulphurous acid, calcium and water, and during the first 3 to 5 mins., during which the sodium acts on the water present, with sodium and 96 % alcohol. Intense ionisation occurs in the following reactions: the combustion of sulphur; dilute sulphuric acid and zinc, 10 volts/min., but somewhat less with a negative charge; dilute sulphuric acid and magnesium, 20 volts/min.; zinc dust and hydrogen peroxide solution, 20 volts/min.; addition of water to calcium carbide, 10 volts/min., but less when the carbide is dropped below the surface of the water; potassium nitrite and ammonium chloride, 20 volts/min.; sodium hydroxide solution and aluminium, 20 volts/min.; decomposition of ammonium dichromate on a heated quartz dish, 25–30 volts/min.

With discontinuance or retardation of the reaction, the ionisation also exhibits weakening, which is at first rapid, but proceeds more and more slowly, and in some cases, such as the decomposition of ammonium dichromate, occupies more than an hour. With mineral waters and the gases evolved from them it is, therefore, advisable to determine the radio-activity

4 to 5 hours after the sample is taken, since the emanation would then be in equilibrium with its decomposition products, and any reaction between the gases and the salts of the water or the walls of the vessel at an end. The results show also that no relationship exists between the evolution of gases and ionisation. T. H. P.

480. *Relation between Atomic Weights and Velocity of Movement of the Atoms of Elements at their Melting-points: Natural System of the Elements.* **P. P. v. Weimarn.** (Russian Physico-Chem. Soc., J. 47. pp. 481–489, 1915).—The author has constructed three curves, each of which has the atomic weights of the elements as abscissæ, the ordinates being the absolute melting-point T_s, T_s/A, and $\surd(T_s/A)$ respectively. The greatest regularities are shown by the last two of these curves, and especially by the third, the ordinates of which are proportional to the intensity factors of the energy of atomic motion at the melting-points.

The curves lead to interesting conclusions concerning the position of hydrogen in the natural system of the elements. Ramsay, among others, considers that this element is to be regarded as the first member of the halogen group, and Biltz [Abs. 1601 (1911)] states that a study of his curve renders such a position for hydrogen inevitable. The possibility that other elements may yet be found between hydrogen and helium cannot, however, be overlooked. From the value of $\surd(T_s/A)$ for hydrogen and the position of the latter on the curve, this element approaches those capable of existing under ordinary conditions in both the metallic and non-metallic states.

If the values of A and T_s are known and the position of the element in the periodic system, it is possible to determine the magnitudes of many properties of the element at the melting-point, and also, if the temperature-coefficients of these properties are known, at any other temperature.

T. H. P.

481. *Reduction of Metallic Oxides with Hydrogen at High Pressures.* **E. Newbery** and **J. N. Pring.** (Roy. Soc., Proc. 92. pp. 276–285, March 1, 1916.)—Metallic oxides have been heated to temperatures up to 2500° C. in dry hydrogen at pressures up to 150 atmos.; metallic sodium being used to reduce the pressure of the water-vapour produced to as low a limit as possible. Cr_2O_3 and MnO_2 were reduced to the metallic state, while oxides of V, Nb, U, Ti, and Ce were reduced to a lower state of oxidation and never to the metallic state. Al_2O_3, MgO, ZrO_2, Y_2O_3, and ThO_2 were unchanged. The samples of Cr and Mn obtained appeared to be much purer than those prepared by any previous method. The melting-points were obtained by Burgess's method, and the value found for the Mn was 1280° ± 5° C., and for the Cr 1615° ± 15° C. The supposition as to the comparative purity of the metals was borne out by the sharp nature of the melting-points, a feature which is lacking in samples prepared by other methods. In the reduction of V_2O_5 in hydrogen at 75 atmos. pressure V_2O_3 and VO were produced. V_2O_3 is a black substance with a beautiful steel-blue iridescence, and is a good conductor of electricity. VO is a silver-white metallic-looking substance which conducts electricity like a metal and possesses chemical and physical properties almost identical with those of metallic V. CeO_2 was reduced to Ce_2O_3, a body which is very difficult to prepare by other methods.

F. C. A. H. L.

482. *Metallography of Steel for U.S.A. Naval Ordnance.* **H. E. Cook.** (Am. Inst. Mining Eng., Bull. No. 110. pp. 375–400, Feb., 1916.)—In its

specifications for gun forgings the U.S. Bureau of Ordnance reserves the right to make such microscopic examination as it may deem necessary, and has accordingly equipped various inspection offices with microscopic outfits with the object of studying the value of metallography as an aid to inspection. The author describes the initial results of these studies, and reproduces photomicrographs of various test-pieces cut from casting and forgings, used in ordnance manufacture. The structure of the castings indicates that there is room for considerable improvement in their thermal treatment.

F. C. A. H. L.

483. *Transformations in Alloys of Gold and Copper.* **N. Kurnakov, S. Shemtschushni, and M. Zasedatelev.** (Russian Physico Chem. Soc., J. 47. pp. 871–897, 1915.)—That alloys of copper and gold represent a typical example of isomorphous mixtures of two metals in all proportions has been shown by investigations of their fusion diagrams [Abs. 1599 (1907)], microstructure, electrical conductivity, hardness [(Abs. 807 (1909)], and other properties. The original measurements of the hardness (*loc. cit.*) were made on cast specimens by means of the sclerometer. Later, after Brinell's method had been found to yield good results in other cases, it was applied to Cu-Au alloys. The preliminary measurements confirmed the existence of a very distinct maximum of hardness (200 kg./mm.^{2}) at about 50 at. % of gold, but yielded a diagram, the form of which was not in agreement with that required by theory for a series of solid solutions. The authors have, therefore, carried out a new series of systematic investigations of the cooling curves, microstructures, hardness, and electrical conductivities of the cooled and tempered alloys. The results of these measurements, which are given in detail, show that the continuous isomorphous mixtures of copper and gold, or the α-solutions, are stable only at temperatures of 367·8° (50 at. % Au) and 370·8° (25 at. % Au). Below these transformation-points, decomposition of the isomorphous mixtures occurs, with separation of the definite compounds CuAu and Cu_3Au, which form solid solutions with excess of their components. The very simple forms of electrical conductivity and hardness diagrams previously observed correspond with a continuous series of α-solid solutions of Au and Cu, the decomposition of these not being noticed during the cooling of the fused alloy. The transformation of such a solution with separation of the new phases requires a moderately long time, and the necessary tempering may be considerably delayed. Closer examination of the influence of tempering and cooling on the alloy containing 50 at. % Au reveals an interesting difference in properties between the α-solid solution and the auride, CuAu, which is the product of the transformation at temperatures below 370·8°. The α-solution is a comparatively soft, plastic substance, which can be rolled or drawn out into wire, whilst the compound, CuAu, exhibits marked hardness and brittleness, in consequence of which rolling or drawing is impossible. Thus, with this alloy (50 at. % Au), the influence of tempering and cooling on the properties of the solid is the reverse of that with many other metals.

T. H. P.

484. *Gold-Cadmium Alloys.* **P. J. Saldau.** (Russian Physico-Chem. Soc. J. 46. pp. 994–1027, 1914.)—The author has made a complete investigation of these alloys with reference to the electrical conductivity at temperatures up to 700°, the hardness, the peculiar properties of the eutectic alloys, the temperatures of crystallisation and transformation, the e.m.f., and the microstructure. The results of the measurements are expressed in the form of tables and curves, and a number of photomicrographs are given. A special apparatus, comprising an electric furnace, has been devised for conductivity measurements on the solid alloys up to 700°, and would be applicable to the study of the dissociation of solid compounds, etc.

The results show that gold and cadmium form two compounds, AuCd and $AuCd_3$, giving solid solutions with their components within the limits 46–59 at. % Cd for AuCd, and 74–79 at. % Cd for $AuCd_3$. The mono-auride, AuCd, is characterised by Dalton points, both in its fusion diagram and in the isotherms of electrical conductivity and hardness. The diagrams of electrical conductivity and hardness for phases of variable composition, including the mono-auride, correspond perfectly with the theoretical diagrams for a definite chemical compound giving solid solutions with its components, the maximum of conductivity persisting at all temperatures from 25° to 600°. The supposed compound, Au_4Cd_3, described by Vogel, has no real existence, its composition merely corresponding with the limiting solid solution of the mono-auride with gold. Gold and AuCd, and cadmium and $AuCd_3$, form solid solutions containing, respectively, up to 35 at. % of Cd and 2 at. % of Au.

Eutectic alloys of Au and Cd in a condition of equilibrium differ markedly in their properties from the neighbouring alloys, exhibiting relatively great hardness and low values for the electrical conductivity and its temperature-coefficient and for the potential. Consequently, the existing schemes for the rectilinear expression of these properties are inapplicable to Au-Cd alloys in the eutectic region, such alloys approximating in their properties to solid solutions. T. H. P.

485. *Hardness of Copper-Zinc Alloys.* **D. Meneghini.** (Ann. Chim. Applicata, 3. pp. 95–101, 1915.)—The author's measurements were made by a modification of Le Gris' method (Rev. de Mét. 10. p. 1058, 1913), in which the hardness is calculated from the diam. of the imprint made on the specimen by a steel ball subjected to a relatively small pressure.

With more than 55 % of Zn the alloys become hard, brittle, and difficult to work, and with 78–88 % of Zn they are porous, and remain so even after re-fusion. From 0 % to 50 % of Zn the hardness curve is much flatter and less sinuous than was found by Turner and Murray, who observed also great irregularity in the region of about 90 % of Zn, probably owing to the difficulty of obtaining perfect equilibrium in the solid phase. Indeed, the author finds that in alloys containing 20–30 % of Zn appreciable variation in the hardness may be caused by imperfect re-heating.

Comparison of the hardness curve with that of electrical conductivity, deduced from the data of Haas, Weber, and Matthiessen, gives a further confirmation of Guertler's rule, according to which increased hardness of an alloy corresponds with diminished conductivity [Abs. 1186 (1907)]. In both the hardness and conductivity curves a change in direction occurs at about 36·5 % of Zn, corresponding with the first appearance of the γ-constituent; alloys containing 0–36 % of Zn consist exclusively of homogeneous α-solid solutions. The hardness increases very considerably as the proportion of γ-modification becomes greater, and at about 60 % of Zn, where the α-constituent disappears entirely from the solid, it has increased almost fourfold. With the presence of the ε-form corresponds the zone of greatest porosity, which ceases with the appearance of the η-constituent. In spite of the coincidence of the maximal hardness with the composition, Cu_2Zn_3, the curve is insufficient to prove the existence of definite compounds, but it confirms the conclusion that 40 % of Zn is the maximum permissible in alloys to be utilised industrially. T. H. P.

486. *Recrystallisation of Cold-worked Alpha Brass on Annealing.* **C. H. Mathewson** and **A. Phillips.** (Am. Inst. Mining Eng., Bull. No. 109. pp. 1–50, Jan., 1916.)—Contains the results of experiments on the properties and microstructure of commercial rolled brass following annealing. The early effects of annealing upon the physical properties of worked brass are shown by testing 70/30 brass after a preliminary reduction of 40 % by rolling and also after annealing at 200° C. for 30 minutes. The results show that this annealing causes a slight increase in tensile strength from 76,763 lbs. per sq. in. to 78,512 lbs. with a corresponding decrease in elongation from 11·1 % to 10·0 % and an increase in hardness from 33·2 to 34·2 on the scleroscope scale. This change in properties is not accompanied by any microstructural change which can be detected, and shows that the degree of internal strains may be diminished by reheating to temperatures below the softening of the metal. The results obtained show that there may be an actual increase in tensile strength associated with the partial release of strains in rolled shapes.

The time required at different annealing temperatures between 225° and 325° to produce a drop of 3 points in scleroscope hardness was determined for 70/30 brass which had received 40 % reduction by rolling after a dead-soft anneal. The results showed that 294 hours were required at 225°, 189 hours at 240°, 46 hours at 255°, 5¼ hours at 275°, 2¼ hours at 300°, and 18 minutes only at 325° C. At 375° and 425° the loss in hardness was 8 and 13 points on bringing the specimen up to the furnace temperature, which required 5 minutes. The examination of a large number of specimens showed that any positive indication of softening by the scleroscope can be detected in the form of recrystallisation under the microscope.

The effect of different degrees of reduction by rolling was determined on alpha brass containing 64 % Cu. Reductions of 5 or 10 % have little or no effect on the etching properties; at 20 % reduction the etching properties begin to change owing to the development of a secondary structure within the grains themselves. At 30 % reduction the direction of extension in cold-working becomes apparent, the grains show a prevailing direction of elongation, and lines of deformation appear at about a right-angled direction to that of elongation. These deformation lines become more apparent with still greater reductions.

The principal relations between deformational treatment and structural characteristics after anneal are considered. There is for each metal or alloy a minimum temperature at which recrystallisation will start from a condition of max. resolution into fragments of minimum size. In the case of alpha brasses whatever the extent of reduction beyond 15 or 20 %, annealing at temperatures above 550° will give uniform grain characteristics. A considerable amount of attention is given to the structural changes developed in 70/30 cartridge brass by uniform anneal at temperatures within the range 350° to 800° after reductions of 2, 4, 8, 12, 15, and 25 % respectively, these reductions being obtained by rolling brass of max. softness. In the case of 2 % reduction, no evidence of recrystallisation can be detected within this range of temperature. After 4 % reduction, a distinct refining resulted from the anneal at 650°; after 8 and 12 % refining is found at 550°; after 15 %, at 450°; after 25 %, at 350°; and after 40 %, at 275°. The specimens used for obtaining these results were also used for determining the distribution of the drop in hardness as a result of the anneal. When plotted in curves, the results show that there is a maximum on each curve, which shows that particularly active recrystallisation occurs at the temperature indicated. The curves, however, representing softening after the higher reductions of 50, 25, and 15 %, and after the minimum reduction of 2 % show sharp maximum points, while the curves from the medium reductions of 12, 8, and 4 % show comparatively flat maxima, representing recrystallisation over a considerable range of temperature.

A comparison is made of the ordinary physical properties and grain-size in samples of alpha brass after a 30-minute anneal at different temperatures, and a series of curves is given to illustrate this in the case of a brass after a 30-minute period of annealing. The curves representing percentage elongation rise rapidly in the temperature region which corresponds to a rapid fall in number of grains present, and reach maxima in the region which corresponds to the most gradual changes in grain-size. The curve representing reduction of area shows a maximum in the temperature region which corresponds to rapid change in number of grains present. The curves representing hardness and tensile strength bear no close relation to the number of grains present. The highest combined values of reduction of area and elongation are obtained in the brass containing 66·56 % Cu by annealing at 650°. This corresponds to 8 grains per sq. in. at a magnification of 85 diameters.

The paper is illustrated by 60 photomicrographs of alpha brass. C. O. B.

487. *Electrically-heated Bomb Furnace.* **D. F. Calhane** and **H. A. Lavene.** (Met. and Chem. Eng. 14. pp. 140–143, Feb. 1, 1916.)—Calculations for the design and construction of such a furnace (for carrying out certain classes of chemical reactions in sealed glass tubes) are given in full, with illustrations. L. H. W.

488. *Isotopic Elements.* II. **K. Fajans.** III. **G. v. Hevesy** and **F. Paneth.** (Phys. Zeits. 17. pp. 1–4, and pp. 4–6, Jan. 1, 1916.)—[See Abs. 258 (1916).] A. B. W.

489. *Allotropic Modification of Lead.* **H. Heller.** (Zeits. Phys. Chem. 89. pp. 761–762, May 28, 1915.)—It was accidentally observed that lead strips, left for several weeks in a solution of lead acetate and nitric acid after electrolysis, had turned grey and brittle and could easily be powdered between the fingers. The lead had been pure, containing only traces of iron. Other pure lead placed in a similar solution for 8 days without electrolysis behaved similarly. Lead nitrate and even chloride also transformed lead into the grey modification, in the presence of nitric acid, though very slowly; in the absence of lead ions a modification did not appear to take place; but attempts to inoculate pure lead with the grey modification failed. The observations agree with Cohen and Helderman. H. B.

490. *Cold-working of Copper.* **L. Guillet.** (Rev. de Mét. 12. pp. 819–828, Sept., 1915.)—The study of the relationship of hardness to tensile strength in the case of copper-zinc alloys [Abs. 938 (1915)] has been applied to copper. In the case of the brasses it was found that the relation of the tensile strength to the ball hardness could be expressed approximately by the equation $R = 0{\cdot}50\Delta$, and, further, it was shown that the ball hardness is an excellent measure of the degree of cold-working. Preliminary experiments on copper

showed that the ball hardness of copper is not independent of the diam. of the ball nor of the magnitude of the load. With a 10-mm. ball the apparent hardness decreased with decrease in the load, while with a 5-mm. ball the hardness increased with decrease in the load. Further, it was found that the condition of the surface exerts a considerable effect on the value of the hardness obtained, and, particularly with soft metals, it is necessary to take great care in the preparation of the surface prior to testing. Rectangular bars of copper 8 × 10 mm. in section were placed in a groove 8 mm. wide in a block of steel, and the height of different bars was reduced to 9, 8, 7, 6, and 5 mm. by hammering a hard steel bar placed in the groove on the top of the bars. Each bar was then submitted to tensile tests, ball-hardness tests with a 10-mm. ball under a load of 500 kg., and also to microscopic examination. The results show that the hardness increases rapidly with the degree of cold-working, but that it soon approaches a max. value. Only for low degrees of cold-working can the hardness be taken as a measure of the degree of deformation. The microscope, however, provides a ready means of determining the degree of cold-working except for very great deformations. In cold-worked copper there is no relationship existing between the tensile strength and the ball hardness, for the ball hardness increases at a much greater rate than the tensile strength. This point appears to be a general rule for all metals and alloys. F. C. A. H. L.

491. *Theory of Emulsification.* VIII. **W. D. Bancroft.** (J. Phys. Chem. 20. pp. 1–31, Jan., 1916.)—Consideration of the work of Rayleigh, Worthington, Schuster, Campbell, Newall, Kaiser, etc., leads to the following general results :—All solids exhibit selective adsorption of gases and vapours. The film of condensed gas shows itself in the abnormal mobility of very fine powders, in a resistance to the passage of an electric spark between solid terminals, and in the fact that two pieces of a broken object will not reunite when pressed together. All liquids also show selective adsorption of gases and vapours ; the film of condensed gas, which reveals its presence in the behaviour of fountains, impinging jets, rolling drops, and soap-bubbles, causes errors in the determination of molecular weights by the air-bubbling method. The adsorption of gas on the surface of mercury is not sufficient to account for the change of the surface tension of mercury with lapse of time. T. H. P.

492. *Black Phosphorus.* **P. W. Bridgman.** (Am. Chem. Soc., J. 38. pp. 609–612, March, 1916.)—It is now shown that black phosphorus [see Abs. 1745 (1914)] is stable in comparison with the white modification at 200° under pressures above 4000 kg./cm.^{2} and probably also at lower pressures. Violet phosphorus is stable compared with white at 4000 kg./cm.^{2} and somewhat below 200°, and is stable in comparison with the red variety at 200°, at least between the pressures 8000 and 12,000 kg./cm.^{2}. The relative stability of violet and black phosphorus at high pressures could not be determined, since the transition from violet to black could not be realised, even with catalysts effective in the other phosphorus transitions. T. H. P.

493. *Influence of Current Wave-form on the Silent Discharge and on Ozone Formation.* **G. Lechner.** (Zeits. Elektrochem. 21. pp. 309–324, July 1, 1915.)—The influence of the wave-form of the current, first studied by Róka, is observed by the method of K. B. Owens, the electrodynamometer having one movable and two fixed coils. The curves are reproduced. Two series of experiments were made, with dried oxygen from cylinders, and with an air current, always at ordinary temperature and atmospheric pressure and with alternating and with interrupted direct currents of the same periodicity, 42 $\sim$. The rule of Warburg and Leithäuser, that the yield of ozone is approximately proportional to the mean current strength, is confirmed. Flat current and potential waves are recommended, since they give higher yields per watt-hour and a higher efficiency factor. It is pointed out that alternating currents undergo a partial rectification in metallic ozonisers. H. B.

494. *Properties of Mixed Liquids. I. Sulphuric Acid-water Mixtures.* **J. L. R. Morgan** and **C. E. Davis.** (Am. Chem. Soc., J. 38. pp. 555–568, March, 1916.)—Many determinations of the surface tension of 48 sulphuric acid-water mixtures have been made at various temperatures by means of the drop-weight method and the constants of the formula $\gamma_t = \gamma_0 + \alpha t + \beta t^2$ derived, so that the surface tension and specific cohesion may be calculated for any concentration and for any temperature between 0° and 50°. The surface tension is increased by addition either of sulphuric acid to water or of water to sulphuric acid; a similar increase also accompanies addition of sulphur trioxide to sulphuric acid. The results appear to indicate the existence of the hydrate, H_2SO_4,H_2O, with 85 % of the acid. According to Denison [Abs. 318 (1913)], the max. deviation of a property from the law of mixtures corresponds with the formation of a compound between the components. On this basis the presence of the following hydrates of sulphuric acid in aqueous solutions of the acid is indicated: by the density, compressibility, viscosity, and refraction, H_2SO_4,H_2O; by the refraction, $H_2SO_4,2H_2O$; by surface tension, $H_2SO_4,3H_2O$; by conductivity and viscosity, $3H_2SO_4,H_2O$; by conductivity and density, $H_2SO_4,12H_2O$; and by viscosity, $4H_2SO_4,H_2O$, or $5H_2SO_4,H_2O$. T. H. P.

495. *Colloidal Solid Solutions.* **D. McIntosh** and **R. Edson.** (Am. Chem. Soc., J. 38. pp. 613–615, March, 1916.)—"Colloidal solid solutions" have been prepared by plunging a copper tube containing a salt solution into a refrigerant, such as CO_2 and ether. The tube was subsequently removed and plunged for an instant in warmer water, the frozen block being then extracted, placed in a test tube, and examined at a suitable temperature. This frozen material is more opaque and softer than ice, and may be ground to any degree of fineness in a cooled mortar. Under the microscope it appears perfectly homogeneous and shows no evidence of the formation of ice or salt crystals, so that the particles may be colloidal in size; its composition is uniform. Such a solid conducts slightly at low temperatures, and when direct current is used the electrodes polarise and the salt is decomposed; the resistance is very high, but may be diminished several thousandfold by a rise of 30 deg. in temperature. A finely powdered solution of this type gives on melting the exact temperature at which the original liquid would be in equilibrium with pure ice, so that they can be used to maintain any desired temperature, for instance, in a Dewar flask. Measurements at various temperatures of the thermal conductivities of 10 %, 20 %, and 30 % aqueous solutions of potassium iodide are given, the results showing that the conductivity increases most rapidly at about −21°, which is the cryohydric temperature; it seems, therefore, that even with rapid cooling a certain amount of segregation takes place. T. H. P.

496. *Theory of Liquid Potential-differences. I.* **K. H. A. Melander.** (Zeits. Phys. Chem. 90. pp. 59–69, June 15, 1915.)—Mathematical proof of the

possibility of accurately calculating the p.d.'s between two incompletely dissociated electrolytes with a common ion. Experiments are to follow, and the theory is then further to be developed. In many calculations complete dissociation had been presumed, although it is understood that the dissociation is incomplete, and that the non-dissociated molecules may influence the potential; reference is made to Negbaur and Nernst. The author assumes that all the solutions are so diluted that the gas laws hold for dissociated and non-dissociated molecules; that there is only one electrolyte, or that the substances are binary electrolytes with a common ion; that the total current (not the partial currents) is zero, and the current density zero at any point; and that a stationary condition is established in the transition layer between the two surfaces in contact. H. B.

497. *Structure of Electrolytic Copper.* **A. Sieverts** and **W. Wippelmann.** (Zeits. Anorg. Chem. 91. pp. 1–45, Feb. 2, 1915.)—The electrolyses were conducted in a glass cell, 20 cm. in diam., 10 cm. deep, provided with an anode ring (sewn up in parchment paper) lying horizontally near the bottom, and with several (mostly 4) iron rods of 2 cm.^{2} as kathodes near the surface; the unexposed kathode surface was covered with varnish, the exposed surface freshly cleaned with emery, for each experiment. A Witt stirrer was used. Most of the deposits, up to 0·3 mm. in thickness, separated easily from the kathode. The electrolyte, acid sulphate, and other salts, was used with and without colloids, gum arabic, glycerol, egg albumen. The very fine crystalline deposit, or acid sulphate, did not adhere to the kathode, and was very hard on that side (sclerometer test); it contained V-shaped crystals whose size diminished with increasing current density up to a limit, the structure then becoming irregular; this limit was delayed by higher acidity and the presence of colloids. Neutral sulphate yielded brittle copper not free from cuprous oxide. Acid nitrate gave dendritic growths. The addition of colloids generally made the deposits brittle and their presence in the copper could quantitatively be proved even with very small amounts of colloids, which did not affect the microscopic structure; greater amounts influenced structure and potential. The presence of colloids frequently, though not always, was marked by bronze or yellow tints; large additions of colloids produced lamination. Deposits from alkaline electrolytes had no recognisable structure and adhered to the kathode. H. B.

498. *Anodic Solution of Lead.* **N. M. Bell.** (Faraday Soc., Trans. 11. pp. 79–90, Oct., 1915.)—By electrolysing solutions of lead acetate, sodium acetate, potassium hydrogen tartrate, hydrofluosilicic acid, potassium bromide and sodium thiosulphate at various current densities, it is shown that an anode of pure lead loses in general more lead than is in accordance with Faraday's law for divalent ions. By using a blank electrode, that is, a piece of lead of the same size as the anode, but not connected with the source of current, and by means of time experiments, it is shown, however, that in the case of solutions of lead acetate, potassium hydrogen tartrate, hydrofluosilicic acid and potassium bromide, this extra loss is due to chemical solution and mechanical detachment in cleaning, and not to lead dissolving as monovalent ions. In the case of solutions of sodium acetate and sodium thiosulphate, particularly the latter, the evidence seems to show that some of the lead dissolves as monovalent ions and the respective percentages of Pb.-ions formed are calculated to be 2·8 and 5·6. T. S. P.

499. *Single Potentials in the Silver Cyanide Plating Bath, as affected by its Composition and Concentration.* **F. C. Frary** and **R. E. Porter.** (Am. Electrochem. Soc., Trans. 28. pp. 307–324, 1915.)—The single potentials of mercury, silver, copper, brass, and iron in solutions of potassium silver cyanide with various proportions of potassium cyanide in excess, and with and without potassium chloride and hydroxide in amount equivalent to the silver, have been measured and compared; the conductivities of the solutions were also determined. The values for iron and brass are somewhat uncertain; with the former metal there is delay in attaining equilibrium and difficulty in obtaining a reproducible electrode, whilst with brass the free zinc has an effect which could not be determined. Some determinations made with zinc electrodes show that this metal is decidedly negative with respect to silver. Copper and brass are only slightly negative to silver in the solutions used, and their behaviour is not affected by the presence of chloride or hydroxide in the proportions studied. Iron and mercury are definitely positive to silver when at least 10 % of free cyanide is present, but negative to it in the absence of free cyanide. Mercury is not affected by the presence of chloride or hydroxide, but the iron is made about 1·0 volt less positive.

It is probable that the titration of potassium cyanide with silver nitrate gives results which are low to the extent of about 8 % of the cyanide present. Titration with mercuric chloride, in ammoniacal solution and using potassium iodide as indicator, appears to give more correct results. [See Abs. 2016 (1913).] T. S. P.

500. *Electrolysis of Glass.* **A. Speranski.** (Russian Physico-Chem. Soc., J. 47. pp. 52–58, 1915.)—In previous work on the electrolysis of glass, mercury, or its alloys, or fused salts have been employed as anode. The author has replaced these by concentrated sulphuric acid, and has investigated the electrolysis of the following kinds of glass: Jena, "R," hard, lead, and soda. Under these conditions the first four exhibit behaviour similar to that observed by Warburg in the electrolysis of soda-glass with a mercury anode. The soda-glass, on the other hand, becomes opaque, and its electrical conductivity at first falls and later increases rapidly until it exceeds the initial value.

The use of sulphuric acid as kathodic liquid facilitates the investigation of the products of electrolysis of the glass. T. H. P.

501. *Electrolytic Deposition of Zinc at the Surface of the Solution.* **A. A. Titov** and **S. M. Levi.** (Russian Physico-Chem. Soc., J. 46. pp. 909–934, 1914.)—The authors have investigated the phenomenon studied by Mylius and Fromm (1894) and by Freundlich and Novikov [Abs. 1175 (1910)], according to whom, electrolysis of a zinc solution, the surface of which is covered with oil, leads to the separation of a superficial film of the metal. It is found that this film-formation occurs on electrolysis, not only of zinc sulphate solution, but also of solutions of the chloride and acetate, provided these are sufficiently acidified. The phenomenon is favoured by a low concentration of hydrogen ions, but increase of the latter results eventually in hindrance, or even prevention, of the growth of the film. The formation of the film is retarded by the appearance of spongy Zn, and all measures taken to prevent the deposition of the metal in this form are advantageous. The best films are obtained when the Zn is precipitated in a bright, finely crystalline condition, a coarsely crystalline or dark deposit opposing the formation of films. The latter are obtained within wide limits of variation of the current density and of the concentration of the solution, and the lower the concentration the lower the permissible current density. With constant voltage, the current density remains more or less constant during the deposition of the film only at the periphery of the latter, and diminishes rapidly at the lower surface. T. H. P.

502. *Period of Induction and Passivity of Zinc.* **M. Centnerszwer** and **J. Drukker.** (Russian Physico-Chem. Soc., J. 47. pp. 489–469, 1915.)—The following further results have been obtained [compare Centnerszwer and Sachs, Chem. Soc. J., Abs. p. 158, 1915]. Active zinc is covered with a layer of the spongy metal, which is formed only in reactions in which hydrogen is liberated. Removal of this layer results in a new induction period, the passivity being then greater than that caused by polishing with fine emery. By treatment with 10 N-sodium hydroxide, zinc is rendered completely active, whereas a distinct induction period is always observed with zinc activated with iodine solution. Experiments made with zinc from which the adherent surface layer of air has been removed indicate that induction is not conditioned by imperfect wetting of the surface. Zinc is rendered passive to a high degree by heating in a vacuum or in a current of hydrogen, and this passivity is not merely superficial, but extends into the depths of the metal, since treatment with emery removes it only partly, and not to the same extent as with zinc not previously heated. Amalgamated zinc exhibits extraordinarily high passivity, and is not dissolved appreciably by N-hydrochloric acid. This result is noteworthy on account of the fact that amalgamated Al dissolves appreciably more readily than the untreated metal, and even decomposes pure water.

The potential of polished zinc plates increases on dissolution, but the increase soon reaches a limiting value of about 0·02 volt. In every case passive zinc is found to be more noble than the active metal. Passive zinc is activated by kathodic polarisation, and active zinc is rendered passive by anodic polarisation, in spite of the accompanying dissolution of the surface layer.

These results confirm the analogy between the passivity of zinc and that of iron. T. H. P.

503. *Inclusions in Silver Voltameter Deposits.* **G. W. Vinal** and **W. M. Bovard.** (Am. Chem. Soc., J. 38. pp. 496–515, March, 1916.)—A number of silver deposits were heated to temperatures slightly above 600° C. and lost in weight 0·004 % on the average for pure electrolytes and more for impure electrolytes. These results indicate inclusions of foreign matter in the deposits. The most accurate value for the electrochemical equivalent of silver is stated to be 1·11800 mgm. per coulomb, and the value of the Faraday is given as 96,494 absolute coulombs. [See Abs. 98, 752 (1915).] F. E. S.

504. *Electrolytic Antimony Refining.* **A. G. Betts.** (Am. Electrochem. Soc., Trans. 28. pp. 325–337; Disc., 337–338, 1915. Met. and Chem. Eng. 13. pp. 848–851, Nov. 15, 1915.)—The author has investigated the electrolytic refining of antimony, using as electrolyte a solution containing antimony trifluoride, potassium fluoride, and hydrofluoric acid in the proportions given by the formula SbF_3, KF, HF. The antimony anodes used contained 75 to 88% of Sb, and 5 to 12% of As, together with Hg, Pb, Cu, and Bi; the kathodes were of copper. It was found that there was no difficulty in eliminating the elements other than As; that the electrolyte did not become contaminated with impurities, and that a good deposit of antimony was obtained. However, no matter how the conditions of experiment were varied, arsenic could not be eliminated from the Sb deposited at the kathode. Although the results were unsatisfactory, the details given should be of use in further research on the same subject. T. S. P.

505. *Anodic Relations of Passive Iron, with Notes on Polarisation Potentials as influenced by External Gas Pressures.* **H. G. Byers** and **S. C. Langdon.** (Am. Chem. Soc., J. 38. pp. 362–374, Feb., 1916.)—In previous work [see Abs. 1065 (1908), 142 (1915)] it has been established that anodic passivity in iron is influenced by seven critical factors, one of these being the concentration of oxygen dissolved in the electrolyte. The influence of this last factor has now been further investigated by a study of the effect of oxygen pressure on the potential of iron. It has been found that neither mechanical pressure nor the saturation of the electrolyte with oxygen or hydrogen produces a pronounced effect on the e.m.f. of iron when immersed in 0·2N-H_2SO_4. When the iron electrode is held in the passive condition by a small current, the application of oxygen gas under pressure to the surface of the electrolyte causes a fall in the polarisation potential; with the release of the pressure the potential again rises, but not as high as it was when the pressure was first applied. This is not surprising in view of the fact that for an anodically polarised passive iron electrode the value of the potential gradually decreases with time. This change of potential is due to the mechanical pressure exerted, since it is independent of the nature of the gas, hydrogen giving the same results as oxygen. It was therefore probable that the phenomenon is not characteristic of passive iron alone, and further experiments with an iron anode, a Pt anode and kathode, and a copper anode, have shown that on the application of gaseous pressures, anodes and kathodes from which gas is being evolved become more positive and more negative. This result can be explained by Nernst's equation if the anode is considered to be coated with an oxygen film or charged with oxygen, as by occlusion.

Measurements of the variations of polarising current, and of anodic potential during the process of passivification gave curves which indicate that passivification is a two-process operation. The first process consists in the formation of a layer of insoluble material, as, for example, ferrous oxide; the initial formation of this layer corresponds with a rapid fall in potential. The second process corresponds with the establishment of a film of oxygen gas, which finally forms a complete cover over the electrode, and gives a final rapid drop in potential. The transition between these two processes is represented by a slow drop in potential. The curve also indicates that activication is a single process, or at best practically the simultaneous removal of both the oxygen and oxide coats.

It is pointed out that there is no one general explanation of passivity, but rather that in each case the loss of activity is dependent upon the conditions. A theoretical explanation is given for the conditions studied, the explanation being based on the two processes named above—namely, the formation of a layer of ferrous oxide and a film of oxygen gas. The explanation agrees with the fact that dissolved oxygen increases the speed with which passivity is established, but does not materially affect the potential. T. S. P.